International Marine Engineering

MARCH, 1909.

THE HAMBURG-AMERICAN LINE STEAMER CLEVELAND.

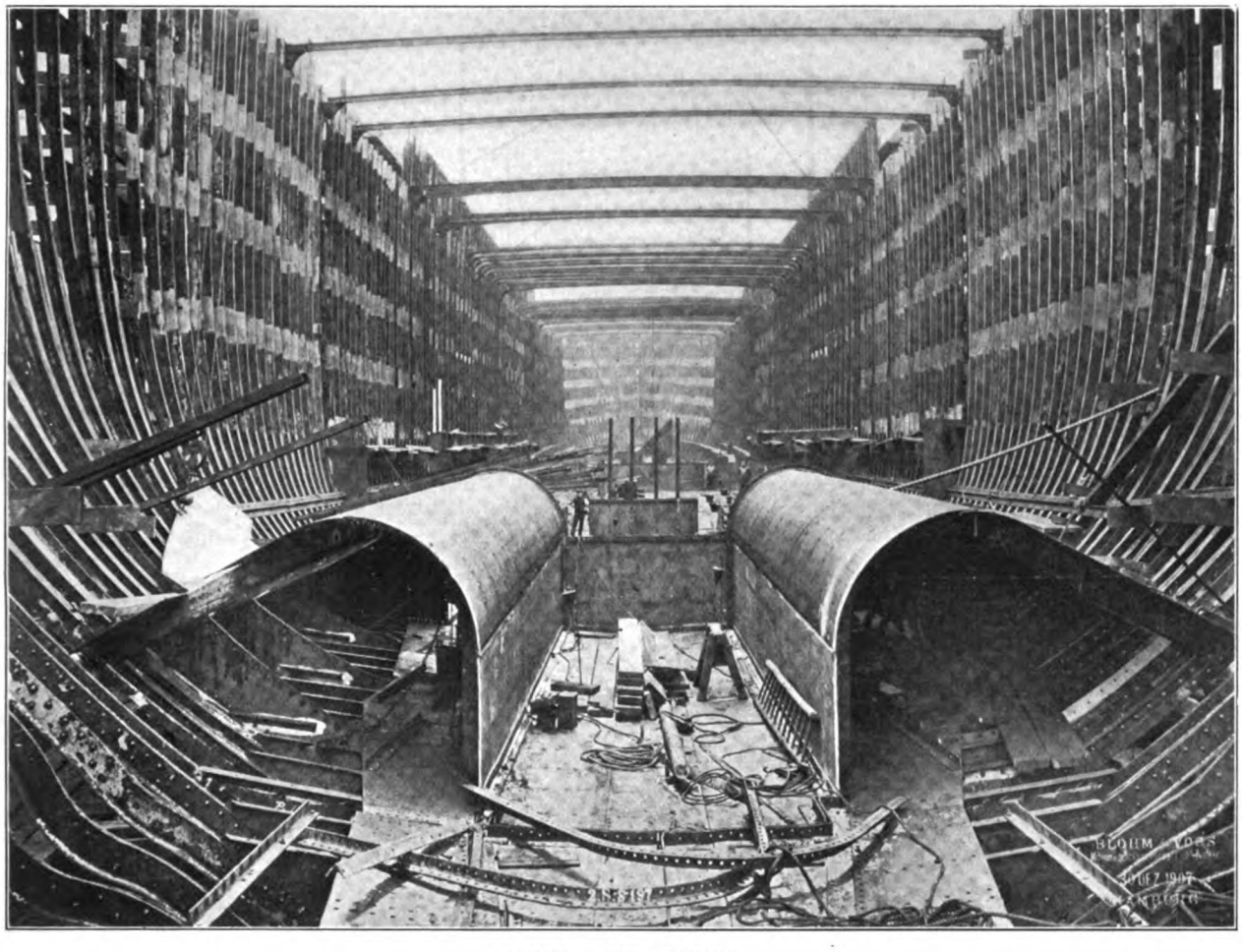
Two new twin-screw steamships are now being built in Germany for the Hamburg-American Line. One of these, the *Cleveland*, was launched from the yards of Blohm & Voss, in Hamburg, on Aug. 14, 1907, and it is expected that she will make her maiden trip to New York this month. The *Cleveland* is built of steel, to the highest class of the Germanischer Lloyd rules, and also in accordance with the regulations of the Board of Trade and the German and American laws for carrying emigrants. The principal dimensions are:

Length between perpendiculars.....	587 feet 6 inches.
Length over all.....	608 feet 8 inches.
Breadth on frames.....	65 feet.
Depth molded.....	50 feet.
Loaded draft.....	32 feet 8½ inches.
Tonnage, gross register.....(about)	17,000
Tonnage, net register.....(about)	10,000
Deadweight capacity, tons.....(about)	13,000
Displacement on 32 feet 8 inches draft..	27,000 tons.

Cargo capacity, including fourth class passenger compartments, about 470,578 cubic feet.

Cargo, cold-storage room, about 35,000 cubic feet.

The ship is rigged with four schooner masts, having six Mannesman tube derricks on every mast, including one capable of carrying 25 tons. The derricks are worked by twenty steam winches of the latest pattern, serving eight hatches in all. A strong windlass and two steam capstans on the forecastle and two steam capstans near the stern, besides two boat or coal-hoisting winches, from the remainder of the auxiliary machinery on deck in addition to the steam steering gear.



FRAMING OF THE CLEVELAND.

The main superstructure amidships extends to 100 feet forward and 154 feet aft the center of the ship, and is gradually tapered away to the uppermost deck. One expansion joint has been provided to prevent heavy stresses on the thinner plating. There are seven decks amidships: The lower, 'tween, saloon, upper, bridge, promenade and boat deck, while fore and aft of the propelling space one extra deck, the orlop, is fitted,

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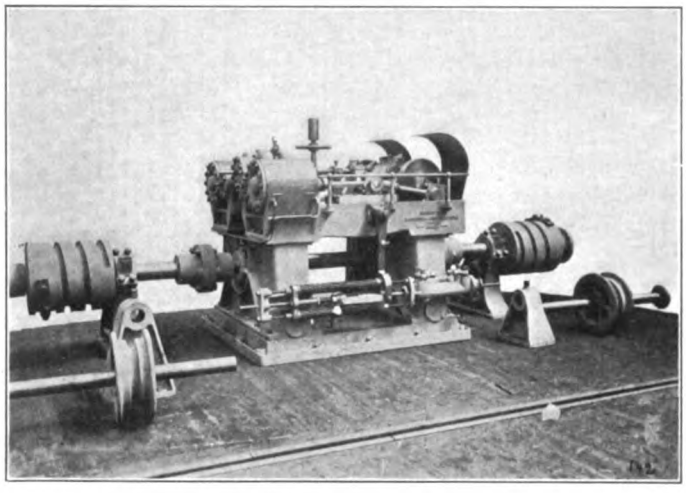
Since the *Cleveland* is built as a hurricane-deck ship, she has no forecastle or poop. There are two deck houses on the forward portion of the weather deck between the large cargo hatches, containing the emigrant galleys and sculleries. The tops of the galley houses are of especially strong design, to support the steam winches for loading purposes. On the after end of the ship two steel houses have been erected, one for another steam galley and one for the second class smoking room and ladies' saloon.

The upper part of the shell plating has been strongly constructed and hydraulic-riveted with snap-head rivets on the outside. The shell below the low-waterline in the fore part of the vessel is 1 inch thick, and has been well stiffened to resist ice. The keel consists of a 52½ by 1-inch plate, with a flat-bar keel, 14 by 3½ inches, fitted below as a rubbing piece. A cellular double bottom, 54½ inches high, with floors on every frame, is fitted throughout the vessel, extending to 80 percent of the ship's breadth. The frame spacing is 30 inches, reduced to Lloyd's requirements for ice-resisting construction



THE STEERING ENGINE.

in the fore part of the vessel. The framing consists of 8⅝-inch channel bars, with web frames fitted two frames apart in the machinery space and every fourth frame in the cargo holds. The deck beams are also of channel section, and are connected to the frames by bracket knees. Three rows of solid pillars are fitted throughout the ship. The engines are placed on top of the cellular bottom, which has been raised for the purpose.

Exposed decks are sheathed with Oregon pine throughout, whereas pitch pine has been used in all covered places and saloons. For the crew spaces and hospitals Litosilo has been adopted; the galleys, pantries, sculleries and refrigerating spaces are sheathed with tiles. India rubber tiles have been laid in smoking rooms, staircases and other passages adjoining first-class passenger accommodations. Bitumastic covering has been used for bunkers, cellular double bottoms and other parts of the steel structure subject to wide variation in temperature, in order to prevent corrosion.

The stern frame and brackets for supporting the tail shafts are cast steel. The rudder is designed in two pieces, in order to unship the lower part while the ship is afloat, having a shaft of Siemens-Martin steel and shrunk-on brackets riveted to a 1-inch single plate. The stem bar is of forged Siemens-Martin steel, formed to take the shell plating, and connected by means of a steel casting to the keel of the ship.

The sub-division by watertight bulkheads and decks is worked out according to the regulations of the Germanischer Lloyd and the See-Berufsgenossenschaft; a system which enables the loaded ship to maintain a satisfactory reserve buoyancy even when two adjoining compartments are filled with water up to the upper deck. To provide for accidents, the watertight bulkhead doors in the main holds have been fitted with the Lloyd-Stone system of closing, whereby all can be closed in a few seconds from the captain's bridge. A powerful hydraulic plant has been fitted to work the doors, and an automatic indicator is placed on the bridge, in order to show the position of each door.

PROPELLING MACHINERY.

The vessel is fitted with two main engines of the four-cylinder, vertical, inverted, direct-acting quadruple expansion type, balanced according to Schlick's system, and each capable of developing about 4,650 indicated horsepower at 80 revolutions per minute. The sequence of the cylinders, beginning forward, is high pressure, low pressure, second and first intermediate pressures, and the diameters of the cylinders are 29½, 42 29/32, 61⅜ and 86½ inches, with a common stroke of 55⅛ inches. The diameter of the crank shaft is 17 inches, the whole length of the shafting being 242 feet. The high-pressure and first intermediate-pressure cylinders have piston valves, the others double-ported slide valves. The diameter of all valve spindles is 4½ inches, that of the piston rods 8 inches. The valves are operated by Stephenson's link motion from eccentrics, and the reversing can be done by steam or hand.

Each of the engines has a main condenser, the cooling surface of which is 7,200 square feet, and each condenser has a separate centrifugal circulating pump of Gwinne's make, the diameter of the impeller being 48 inches. Each condenser has a separate air pump of Blake's design, 12 by 28 inches by 18 inches stroke. The air pump discharges into a tank, from which the water is brought by a Weir pump into a Weir feed-water heater, and from thence by another Weir pump into the boiler. There are three Weir pumps, 20 by 14 by 27 inches, one of them standing by while the other two are working.

There are two propellers of the three-bladed built-up type, which turn outboard when going ahead. The diameter is 19 feet 4 inches; pitch, 21 feet 8 inches; projected area of each propeller, 74 square feet, and developed area 88 square feet.

BOILERS.

Three single-ended and three double-ended boilers, with 214 pounds per square inch working pressure, are placed in one boiler room, the products of combustion passing off through two funnels. One single boiler is situated at the after, the other two single-ended boilers at the fore part of the boiler room, and the three double-ended boilers are placed between them athwartship. The total heating surface of all the boilers is 23,000 square feet, and the grate area 525 square feet. The furnaces are of the Morison corrugated type, having a maximum diameter of 49 inches and an internal diameter of 45 inches, the length of the fire bars being 67 inches. Each double-ended boiler has six and each single-ended boiler three furnaces. The outside diameter of both the ordinary and the stay-tubes is 2¾ inches, and the length between tube plates 94½ inches.

The mean diameter of all boilers is 16 feet 7 inches, the whole length of the double-ended boilers outside the front plates 20 feet 8 inches, and that of the single boilers 11 feet 10 inches. The boilers are fitted with Howden's system of forced draft, the air being supplied by two fans placed in the engine room. The fan wheel is 8 feet 6 inches diameter, and is directly coupled with a single-cylinder steam engine of 8-inch diameter and 7-inch stroke. Each of the boilers is provided with a valve, situated in the uptake, so that it can be shut off from the funnel. The outside diameter of the funnel casing is 14 feet 10 inches, and the height of the funnel above the grate is about 110 feet.

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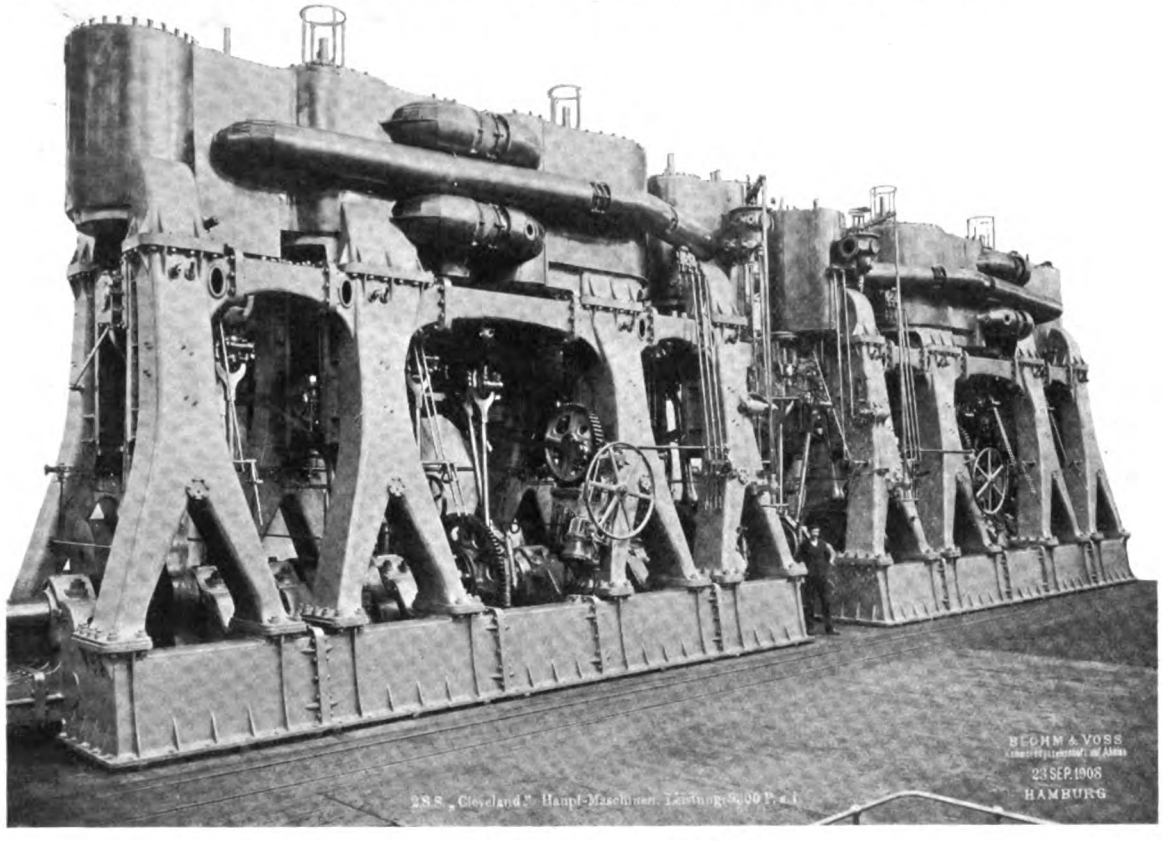
The capacity of the coal bunkers is 2,160 tons, sufficient for about fourteen days at maximum speed and a distance of 5,000 miles. The bunkers are arranged so that the coal can be handled in the most convenient manner.

AUXILIARIES.

The auxiliary condenser has 1,100 square feet of cooling surface, and is placed about 8 feet above the floor level at the starboard side of the engine room. The circulating water can be pumped through the condenser either by the main circulating pumps or by the ballast pump. A separate air pump draws the water from the condenser and discharges it into a floating tank, a vacuum of about 80 percent being maintained. The ballast pump is 10½ by 12 by 10 inches; the three donkey pumps are 13 by 9 by 10 inches. There are three drinking-water pumps, one of 10 tons capacity per hour and two of 5 tons per hour. Two fresh-water condensers, each capable of producing 15 tons of drinking water per twenty-four hours and one evaporator producing 45 tons per twenty-four hours, are also provided.



MAIN ENGINES OF THE CLEVELAND.

The generating plant includes four generating sets, each giving an output of 40 kilowatts. Three sets are located in the engine room between the thrust shafts, the fourth above the waterline on the main deck. The dynamos are driven by compound engines, 10 by 16½ by 7 inches, running at 250 revolutions per minute. The engines were built by the Norddeutsche Maschinen- und Armaturenfabrik, at Bremen, and differ somewhat in appearance from those usually fitted on board the ships. The large main switchboard has twenty-three circuits, of which five are police circuits, one for wireless telegraphy, seven for general lighting purposes, one for the gymnasium, one for lifts, four for ventilator motors, one for motors in the galley, and three for illuminating the ship. The lighting installation is arranged on the single-wire system, except 30 feet round the compasses, where double wires are provided. The police circuits are arranged so that they can be operated independently from a switchboard placed near the emergency dynamo. There are in all about 2,500 lights, of the tantalum type with swan sockets.

There are two refrigerating machines, of Messrs. J. & E. Hall's make, capable of reducing the temperature of the insulated chambers from 70 to 20 degrees F. in about twelve hours. Ten cold cupboards and three drinking-water coolers are provided for pantries, the capacity of the refrigerating rooms being 10,000 cubic feet for provisions, and 30,000 cubic feet for cargo. The cooling is effected by a CaCl solution, which is circulated by three vertical pumps, 4¾ by 6½ by 6 inches. The temperature of each refrigerating room, including cupboards, can be regulated by valves inserted in the brine return pipes close to the evaporators.

The ship is ventilated chiefly by artificial means, each first class cabin having an air trunk with a regulating slide for the supply of fresh air. Passages, lavatories, crew and emigrant spaces are all ventilated artificially, either by supplying fresh air or drawing off the foul air, as the room may require. The fans are all of the centrifugal type, and electrically driven, the motors having starting resistance with an automatic cut-off switch.

The ship is efficiently heated, according to the available space, by steam radiators or copper pipes, which harmonize with the scheme of the decoration. In the staterooms electric heaters are provided.

Loud-speaking telephones connect the navigation bridge with the engine room, forecastle, poop and crow's nest. The electric current for these telephones is taken from the ship's dynamos, and reduced by a resistance from 110 to 12 volts. The first class cabins are also provided with telephones of the ordinary type for intercommunication.

The ship is fitted with a station for wireless telegraphy, the installation of which is carried out according to the latest experience of the Compagnie de Telegraphie sans Fil, Brussels.

The installation of the anchor gear is made by Messrs.

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Clarke Chapman & Company, Ltd., Gateshead-on-Tyne. There are two cable holders for working the anchor cables, which are 3⅛ inches in diameter. The dimensions of the windlass are 15 inches diameter of cylinder and 13 inches stroke. Two capstans for warping are furnished by the Norddeutsche Maschinen- und Armaturenfabrik, Bremen. Each capstan has a separate engine with two cylinders of 12½ inches diameter and 12⅝ inches stroke. The engine is fitted with a link-motion reversing gear, and drives the capstans by a worm and wheel.

The steering gear, supplied by the Norddeutsche Maschinen- und Armaturenfabrik, Bremen, turns the rudder by means of a chain, fastened to the rudder quadrant. The reversing valve is operated by telemotor from the navigation bridge, but it can also be worked by hand from the poop. If the steering engine is out of order the rudder can be moved either by a hand gear or by a steam winch, suitably placed for this purpose.

PASSENGER ACCOMMODATIONS.

The *Cleveland's* passenger accommodations have received most careful consideration, and owing to the spaciousness of the public rooms, decks for promenade, staterooms, passageways, etc., she will be classed among the the finest passenger vessels afloat. The decorations throughout have been placed in the hands of the best artists, and they will be carried out in a quiet and refined taste, similar to the exquisite style of decoration found on the steamers of the *Kaiserin Augusta Victoria, Amerika* and *Deutschland* type. Provision is made for 250 first class, 392 second class, 494 third class, and 2,064 fourth class (German law) passengers, which, with a crew of 360, makes a total of 3,560 persons.

The first class passengers are placed amidships, almost entirely in the superstructure extending over four decks (the saloon, upper, bridge and promenade). The staterooms, with a very few exceptions, have only lower berths, and are of unusually large size. The various decks are connected by means of a grand stairway and a somewhat smaller staircase, and by a separate passenger lift running from the saloon to the promenade deck.

On the promenade deck, in front of the hall, three en suite rooms, consisting of drawing rooms, bed rooms and separate baths, have been provided, having brass bedsteads of special design with no folding berths above. On the bridge deck, in the center of the ship, four special suites have been arranged. Aft on the bridge deck, on each side of the vessel, are two more staterooms with separate baths, and also two single-bed staterooms with baths. Besides these a great number of single and two-berth rooms have been built and carefully fitted with well-selected and finished furniture.

The first class dining saloon on the saloon deck measures about 3,250 square feet, and has seats for 225 passengers at small round tables. The entire floor has been covered with carpet, and incandescent lights of the Globe pattern with bronze mountings, fitted underneath a white enameled ceiling, together with table lamps of a very luxurious pattern, serve to give the room a very pleasing appearance. It has been arranged to give dinners à la carte.

The social hall on the promenade deck, into which the grand staircase leads, measures about 1,300 square feet, and seats about sixty persons. Two desks have also been provided for the hall, and two more are fitted in a special writing-room at the after end of the hall. Between the boiler and engine casing on the promenade deck the music and ladies' saloon is situated. Aft of the engine room casing on the promenade deck, the first-class smoking room of 950 square feet, is reached by a beautifully decorated vestibule, connecting the hall, the music room and the smoking room, as well as by a large staircase leading from the lower deck. Also, entrances have been arranged leading to the open-air promenade and to a bower at the after end of the smoking room. From the vestibule the gymnasium and, by a ladder to the boat deck, the Marconi house is within handy reach for the passengers.

The second class accommodations are similar to the first class, with the exception that the second class public rooms are situated in the after end of the vessel. The dining saloon on the saloon deck, a ladies' room on the upper deck, the lower smoking room and one deck above the upper smoking room, with bar, etc., attached, should give complete satisfaction to any pretentious passenger. In former years such comfortable accommodations on an Atlantic liner would have been considered fully worthy of first class passengers.

The second class dining saloon, which measures about 2,700 square feet, and seats 210, is on the same deck as the first class dining saloon, and is located the same distance aft of the center of the ship as the first class saloon is forward of the center. The after end of the saloon forms one bulkhead of the second class entrance, reaching from port to starboard, with large doors in the shell plating for embarking purposes. In this room the old-style long tables and fixed seats have been fitted.

On the upper deck aft, in a steel house, the ladies' saloon is reached from the cabins below by means of the main staircase. Aft of the main stairs, on the same deck, is the second class smoking room. The top of the above-mentioned steel house, reaching from port to starboard, gives about 10,190 square feet of promenade deck for the second class passengers. From this deck the second class upper smoke room, which is in a separate steel house, may be entered. All second class public rooms, with the exception of the dining saloon, have large square windows in brass frames, thus giving plenty of daylight and fresh air. There is little difference between the first and second class staterooms. The cabins are paneled in white, and mahogany furniture has been fitted throughout.

The third class passengers are accommodated in rooms containing two, four and six in the forward end of the vessel in the lower, 'tween and main decks, of which the main-deck cabins are portable. A large dining saloon, with long tables and revolving chairs, is situated on the main deck, with seats for 234 people. The third class passengers have a promenade fore and aft of the bridge on the upper deck, entirely covered by awnings.

Eleven compartments are fitted in the lower, 'tween and saloon decks to accommodate about 2,064 fourth class passengers, according to German law. Fixed ladders as well as portable ones lead down the hatches for communication between the compartments and the upper deck promenade. Each of the compartments has its quota of seats and tables as well as cupboards for the comfort of the passengers. Large toilets have been arranged on the upper deck, with baths and shower baths. For communication from the forward to the after end of the vessel a wide passage leads through the bridge on the port side, also serving the crew's quarters, which are situated along this side.

For passengers and crew, three physicians, two attendants, two pharmacies, one operating room, two cabin hospitals with four beds, and five other rooms with beds and the necessary baths, are provided near the center of the ship. The following arrangements have also been made for the benefit and comfort of the passengers on board: Wireless telegraphy on the boat deck, gymnasium on the promenade deck, electric light bath on the bridge deck, bookseller's shop on the bridge deck, inquiry office on the bridge deck, barbershop and ladies' hairdressery on the upper deck, with separate entrance for second class passengers, dark room on the upper deck, printing office on the saloon deck.

The first class galley, pantry, confectionery, butchery, bakery, knife-cleaning room and the necessary scullcries, are situated on the port side on the saloon deck, and are fitted with

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all the latest mechanical devices. Special pantries have been provided for the different houses in the other decks of the vessel as well. An important function in connection with the culinary rooms is the placing of provision stores and cold lockers. From the same deck on which the galleys are situated, and from the same working passage, an electric lift for goods runs down to the stores. The second class galley is treated in the same manner as the first, and is situated on the same deck near the second class saloon. The third class passengers have their own galley on the upper deck, forward, which is in due connection by means of a lift to the third class pantry below and with the saloon. There is also a fourth class galley, and separate from these a Kosher (Jew) galley.

Besides the watertight bulkheads and the cellular double bottom the following safety arrangements have been fitted: Sixteen lifeboats and ten collapsible boats on the boat deck and housetops, hanging in Welin quadrant davits; life-belts for every passenger, submarine signals, Lloyd Stone's hydraulic bulkhead doors, large steam pumps, fire bulkheads in the erections above the saloon deck, steam and water fire extinguishing plants throughout the ship, loud-speaking and ordinary (for first class cabins) telephones.

The sister ship of the *Cleveland*, the *Cincinnati*, was launched from the yards of F. Schichau, at Danzig, on July 27, 1908, and it is expected that she will make her maiden trip to New York in May, 1909.

MARINE ENGINE DESIGN.

BY EDWARD M. BRAGG, S. B.

The yokes, Fig. 52, should be figured as beams supported at the ends and loaded at the middle with the load L. The surface of the valve stem guide in the case of single valves, and of the valve-yoke guide in the case of twin valves, should be such as to keep the unit bearing pressure, due to the load P, between 70 and 100 pounds.

The diameter of the eccentric rods and drag rods at the middle should be figured by the connecting rod formula, as

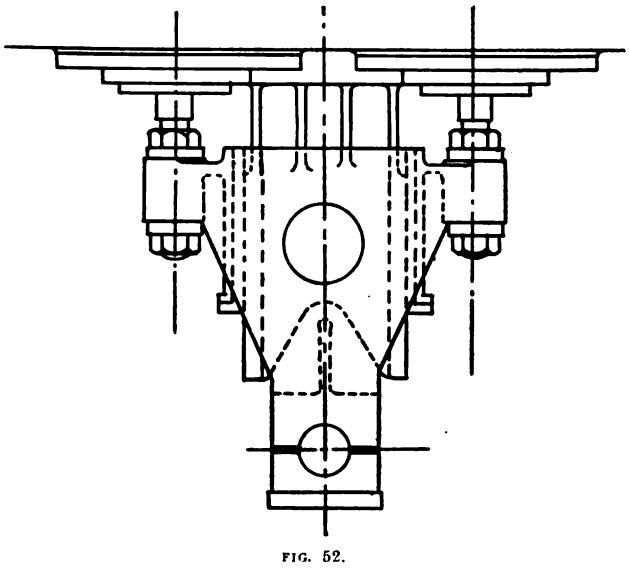

FIG. 52.

they are columns hinged at the ends. The diameter of the drag rods at the ends can be made three-fourths of their diameter at the middle. The diameter of the eccentric rods at the top should be 0.9, and at the bottom 1.1 of the diameter at the middle. The length of the drag rods is usually from $15E$ to $18E$, and of the eccentric rods $20E$ to $30E$ for merchant engines and $15E$ to $20E$ for naval engines. The diameter of the bolts in the caps, etc., should be such as to carry the loads with the factors of safety given in Table IV.

The link is usually of the double-bar type, Fig. 53, and is figured as a beam supported at the ends and loaded at the middle with the load L; as mentioned before, the length of the beam, or distance between eccentric rod pins, a, is usually $6E$. The breadth of the bars b is usually about one-third of the depth c, and the depth is so chosen that the factor of safety

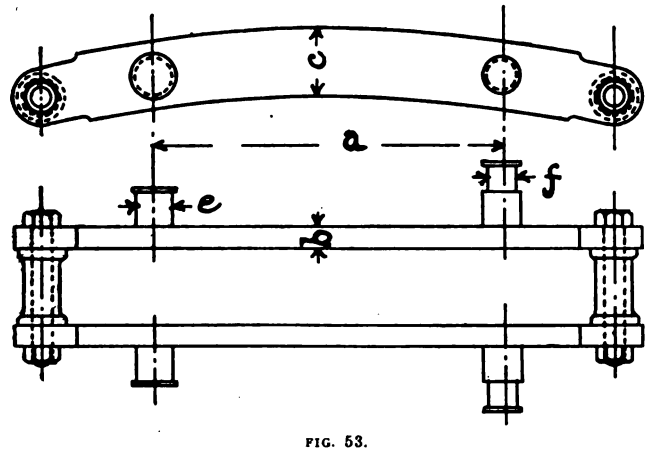

FIG. 53.

will be 12, as the load is alternating. Making this assumption in regard to the relation of breadth and depth, the formula for the depth of each link bar becomes:

$$h = \sqrt[3]{\frac{9La}{4f}}, \qquad (60)$$

where L = load upon valve gear;
a = distance between eccentric rod pins;
and f = allowable stress with factor of safety of 12.

The diameter d of the link block pin, Fig. 54, is from 0.9 to 1.0 of the depth of the bar c; the diameter of the eccentric rod pins e, Fig. 53, is about three-fourths the depth of the link bar, and the diameter of the drag link pin f is about three-fourths the diameter of the eccentric rod pin. The lengths of all these pins, as well as that of the block gibs g, must be such as to keep the bearing pressures within the

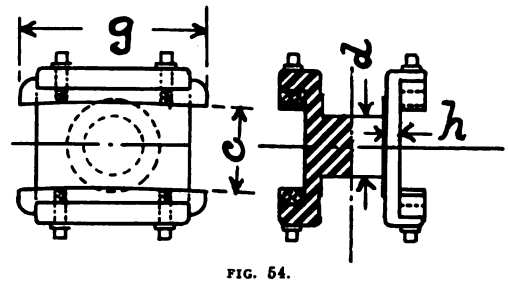

FIG. 54.

limits given in Table VII. The thickness of the metal h joining the link block pin at the sides to the sliding gibs should be from 0.25 to 0.3 of the diameter of the link block pin d.

The diameter of the eccentric will be:

$$D = 2(r + E + c), \qquad (61)$$

where r = radius of eccentric pad on crank shaft;
E = the eccentricity;
$c = \frac{r}{3}$, if the lower part of the eccentric is made of cast iron,
and $= \frac{r}{4}$ if it is made of cast steel.

The upper part of the eccentric, Fig. 55, is always made of cast iron, and joined to the lower part by bolts or collar studs. The keyway should be cut on a line at right angles to the joint

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of the two parts, so that the eccentric can be readily taken off. If the eccentric is so situated that it can be moved along the shaft clear of the key, then the keyway can be on the side, as shown dotted in Fig. 55, and the set screw more conveniently located.

It is well to make the keyway considerably broader than the key in the shaft, and to fit liners on either side, so that slight

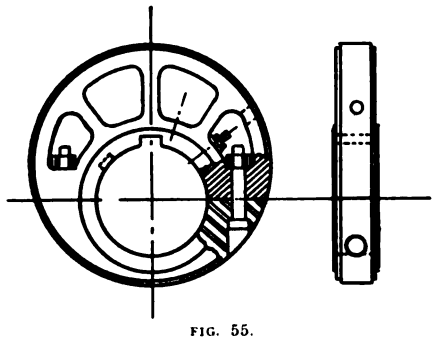

FIG. 55.

changes can be made in the angular advance, if it is thought best. The breadth of the eccentric should be sufficient to keep the bearing pressure within the limits given in Table VII.

The eccentric strap, Fig. 56, should have lips fitting on each side of the bearing surface of the eccentric sheaves, to keep the strap in place. The strap bolts should be designed to carry the load L coming upon the valve gear, as should also the bolts uniting the eccentric rod to the strap. The straps are usually made of cast steel lined with white metal, and the section of the lower half, exclusive of the white metal, should be sufficient to carry the load L with a factor of safety of 8.

The reverse shaft levers, Fig. 51, should be figured for the load $2P$ upon the drag rods, and should be of such a length

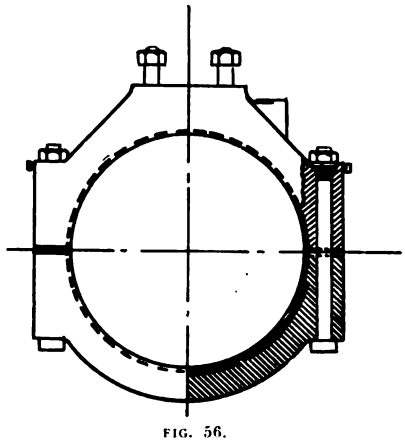

FIG. 56.

that the angle moved through is not more than 80 degrees. The "gag" upon the lever should be so arranged that, in the backing position, the center line of the screw is vertical. This will cause the position of the link, when backing, to be practically the same, irrespective of the position of the end of the drag rod in the slot. In the ahead position of the lever the gag screw will be nearly horizontal, and the link can be pulled in an amount about equal to the travel of the nut on the thread.

The reverse shaft should be figured for torsion and bending, due to the thrust of the drag rods. As it is not always possible to get the bearings close to the various reverse shaft levers, the bending moment may be large in these shafts. The equivalent twisting moment should be found by formula 36. The twisting moment T used in this formula should be that coming upon the portion of the reverse shaft nearest the reversing engine. The reversing engine is usually placed near the middle of the length of the main engine, and it is generally safe to figure the shaft for the twisting moment necessary to move the low-pressure gear; for when these links make the greatest angle with the horizontal plane the other links are in a more advantageous position. In the preliminary design the bending moment can be neglected, and the factor of safety increased from 12 to 15 to allow for this neglect. After taking off the medium-pressure reverse shaft levers, the size of the shaft running to the high-pressure levers can usually be decreased.

In using formula 52, the weight of the valves, valve stems, cross-heads and blocks is usually obtained from data for similar engines. If no such data are available, Fig. 57 can be used to get the weight of valves for purposes of calculation. The ordinates of the curve are the weights of the valves divided by the eccentricity, so that the weight of any diameter

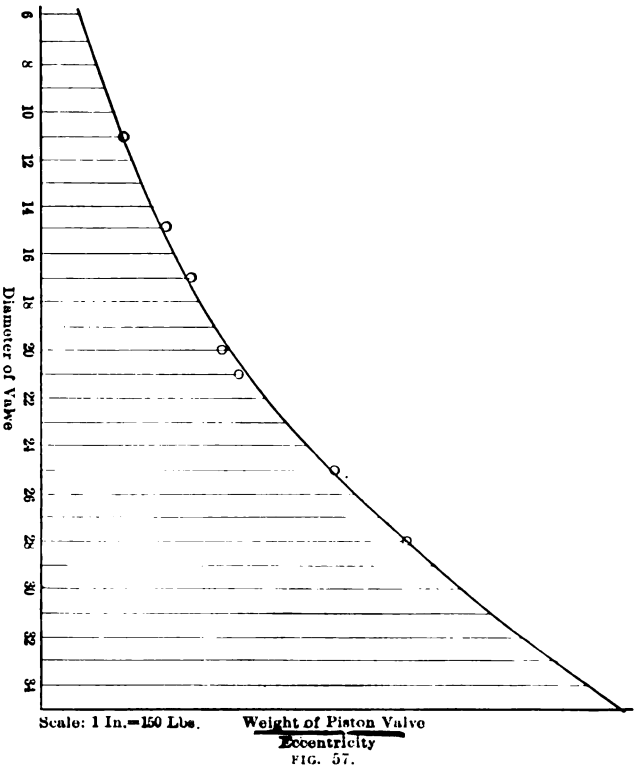

FIG. 57.

of valve can be obtained approximately by multiplying the quantity in Fig. 57 by the eccentricity used. The weight of the other parts can be calculated roughly.

Calculations.—Assumed weights of valve gear are as follows:

High-pressure (12 inches diameter):	
1 valve	325 pounds.
1 stem	350 pounds.
1 block	100 pounds.
	775 pounds.
Medium-pressure (two 17 inches diameter):	
2 valves	1,020 pounds.
2 stems	500 pounds.
1 crosshead	325 pounds.
1 block	100 pounds.
	1,945 pounds.
Low-pressure (two 27½ inches diameter):	
2 valves	2,650 pounds.
2 stems	500 pounds.
1 crosshead	400 pounds.
1 block	100 pounds
	3,650 pounds.

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Formula (54):

$L = [3 + (0.00002837 \times 4.75 \times 120^2)]3{,}650 = 18{,}100$ for low-pressure.

$= [3 + (0.00002837 \times 4.25 \times 120^2)]1{,}945 = 9{,}100$ for medium-pressure.

Formula (59): $P = \dfrac{18{,}100 \times 0.7431}{3} = 4{,}475$ for low-pressure.

$P = \dfrac{9{,}100 \times 0.7}{3} = 2{,}125$ for medium-pressure.

Assume length of drag rods $= 16E = 68$ inches.

Assume length of eccentric rods $= 22E = 94$ inches (approximately).

$f = \dfrac{60{,}000}{12} = 5{,}000$ pounds per square inch.

Drag Rods—Low-pressure Gear.

Formula (27):

$$F = \frac{2 \times 4{,}475}{\pi \times 5{,}000} = 0.572$$

$$D^2 = \sqrt{\frac{1.08 \times 0.572 \times 60{,}000 \times 68^2}{10{,}000{,}000}} + 0.327 + 0.572 = 4.76$$

$D = 2.18$ inches (use $2\frac{1}{4}$ inches) at middle of length;

$2.25 \times 0.75 = 1.69$ (use $1\frac{3}{4}$ inches) at ends.

From Table IV., the load, 4,475 pounds, requires two 1-inch bolts to be used in the drag rod caps.

Eccentric Rods—Low-pressure Gear.

$$f = \frac{70{,}000}{12} = 5{,}840;$$

$$F = \frac{2 \times 18{,}100}{\pi \times 5{,}840} = 1.98$$

$$D^2 = \sqrt{\frac{1.08 \times 1.98 \times 70{,}000 \times 94^2}{10{,}000{,}000}} + 3.96 + 1.98 = 13.65$$

$D = 3.69$ inches (use $3\frac{3}{4}$ inches) diameter at middle of rod;

$3.75 \times 0.9 = 3.38$ (use $3\frac{3}{8}$ inches) diameter at top of rod;

$3.75 \times 1.1 = 4.13$ (use 4 inches) diameter at bottom of rod

The low steam speeds used and the large low-pressure valve resulting, together with the larger eccentricity, make the low-pressure eccentric rods larger than we care to use on the medium-pressure and high-pressure gears, so the rods for the latter will be calculated from the medium-pressure weights and eccentricity.

With $L = 9{,}100$, $E = 4.25$. Formula 27 gives the diameter at middle of medium-pressure and high-pressure eccentric rods $= 3$ inches; diameter at upper end of medium-pressure and high-pressure eccentric rods $= 2\frac{3}{4}$ inches; diameter at lower end of medium-pressure and high-pressure rods $= 3\frac{3}{8}$ inches.

Links.

Formula (60):

$$h = \sqrt[3]{\frac{9 \times 18{,}100 \times 28.5}{4 \times 5{,}840}} = 5.83$$ (use $5\frac{7}{8}$ inches) for depth of link bar.

Breadth of link bar $= \dfrac{5.75}{3} = 1.92$ inches (use 2 inches).

Diameter of link block pin

$= 5.75 \times 0.9 = 5.18$ inches (use 5 inches).

Allowable load, Table VII. = 800.

$\dfrac{18{,}100}{750 \times 5} = 4.83$ inches (use 5 inches for length of pin).

Length of link block gibs

$= \dfrac{18{,}100}{2 \times 2 \times 300} = 15$ inches.

Thickness of metal joining link block pin and gibs

$= 5'' \times 0.3 = 1.5$ inches.

Diameter of eccentric rod pins

$= 5 \times 0.75 = 3.75$ inches.

Length of eccentric rod pins

$= \dfrac{18{,}100}{2 \times 3.75 \times 750} = 3.22$ inches (use $3\frac{1}{4}$ inches).

Diameter of drag rod pins

$= 3.75 \times 0.75 = 2.82$ inches (use 3 inches).

Length of drag rod pins

$= \dfrac{4{,}475}{3 \times 500} = 2.98$ inches (use 3 inches).

Diameter of low-pressure eccentric, which is on a coupling, (see Figure 46), $= 2(11.625 + 4.75 + 3.25) = 39.25$ inches.

Diameter of medium-pressure and high-pressure eccentrics. $= 2(6.375 + 4.25 + 3.25) = 27.75$ inches.

Width of low-pressure eccentric $= \dfrac{18{,}100}{150 \times 39.25} = 3.08$ (use 3 inches). Allowing for $\frac{1}{2}$-inch lip on each side, the total breadth of low-pressure eccentric and strap $= 4$ inches.

Width of medium-pressure and high-pressure eccentrics $= \dfrac{9{,}100}{150 \times 27.75} = 2.19$ (use 3 inches). Allowing for $\frac{1}{2}$-inch lip on each side, the total breadth of high-pressure and medium-pressure eccentric and strap $= 4$ inches.

Diameter of bolts and studs in eccentric sheaves, see Fig. 50, to be 2 inches, see Table IV.

In order that the reverse shaft levers may not have to move through an angle greater than 80 degrees, the length of the levers should be:

$$\frac{4.75 \times 6}{2 \times \sin 37^\circ 30'} = \frac{14.25}{0.61} = 23.4$$ inches (use $23\frac{1}{2}$ inches).

We will place the reversing cylinder between the low-pressure and medium-pressure cylinders, and figure the reverse shaft for the twisting moment from low-pressure gear.

$T = 2 \times 4{,}475 \times 23.5 = 210{,}000$ inch pounds.

$f = \dfrac{70{,}000}{15} = 4{,}670$ pounds.

$D = \sqrt[3]{\dfrac{210{,}000 \times 5.1}{4{,}670}} = 6.12$ inches (use 6 inches) for the diameter of the reverse shaft.

Assuming that the turning moment necessary to reverse the high-pressure gear is one-half that for the low-pressure gear, the size of shaft beyond where the medium-pressure reverse shaft levers are taken off can be made 5 inches.

An error in the article "Recent Additions to the British Fleet," published in our January issue, has just been brought to our attention. The article stated that although the old *Inflexible* had two turrets mounted *en echelon*, all the guns could not be fired on both broadsides, whereas in the new *Inflexible* all the guns mounted *en echelon* on the upper deck could be trained to fire on either side of the ship. As a matter of fact, the deck plan of the old *Inflexible* shows three separate erections on the main deck—one at the bow, one at the stern and one in the center of the ship. These were connected by narrow bridges, and there was ample space between the separate parts of the superstructure to train the guns in either turret across the ship.

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A NEW TYPE OF TORPEDO BO AT.*

BY HUDSON MAXIM.

A little while ago, the Whitehead automobile torpedo was thought to be a valuable adjunct to the armament of the modern battleship, but the range of the guns has now been so increased that such torpedoes become a useless incumbrance, because of the shortness of their range, notwithstanding the fact that their manufacturers have done everything possible to perfect them and to increase their speed and range. Their range is necessarily limited to that attainable by the charge of compressed air they are capable of carrying.

During the past few years, the air pressure has been increased from 1,300 pounds to the square inch to 2,250 pounds to the square inch, and the weight of air from 60 pounds to 130 pounds in the 18-inch torpedo; and still the maximum range of the 18-inch torpedo is only from 3,000 to 3,500 yards, practically about one-third of the range of the high-power guns which determines the distance apart of the lines of battle; and the maximum rate of speed of this torpedo is about 35 knots.

In order to carry the air under the enormous pressure, a very strong and very heavy steel air flask is needed; and as the weight of the entire torpedo must not exceed the weight of the water displaced by it, the propelling mechanism has necessarily to be made very light and delicate for the energy it has to transmit.

But what is far more important, the explosive charge also has to be reduced to a minimum, in order to float the heavy air-flask and the weight of air it contains; and this notwithstanding the fact that the quantity of high explosives ought to be greatly increased in order to ensure destruction of the warship struck by it. In the recent war between Russia and Japan, the Whitehead torpedo proved a great disappointment.

If the speed of an automobile torpedo could be increased 50 percent, its accuracy also would be greatly increased, for it would be far less affected by currents, and would be far more likely to strike a moving target, while if its range could be increased 100 percent, it would then become an efficient adjunct to the armament of every war vessel, whereas if its range could be increased to 5 miles—practically three times what its range now is—even though its speed were to remain at 35 knots, it would be able to pass over the intervening space separating the lines of battle of opposing fleets.

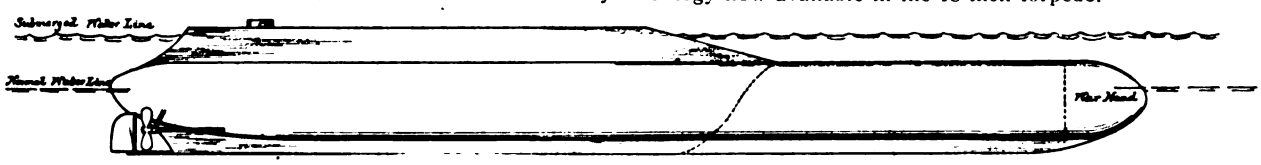
During the last ten years I have conducted a large number of experiments at a cost of more than $50,000 in the development and demonstration of a system for the propulsion of automobile torpedoes and torpedo boats by energy derived from the products of combustion of a self-combustive fuel called motorite, consisting of 70 percent nitroglycerin and 30 percent guncotton. The guncotton is gelatinated by the nitroglycerin, forming a dense, tough and rubbery material. This material is made into bars about 7 inches in diameter and 6 feet long, for use in torpedoes the size of the 18-inch Whitehead torpedo. For the 21-inch torpedo, the stick will be both bigger and longer.

The motorite bars are forced into and sealed in steel tubes for use, and these steel tubes containing the motorite are inserted into the torpedo and are surrounded by a water-jacket. The motorite can be ignited and can burn only at and from one end, and water is forced through the water-jacket into the combustion chamber, to be evaporated by the flame blast forcing the water along with it through an atomizing device, whereby it is instantly converted into steam, and the combined steam and products of combustion form the motive fluid.

The water will be taken in from the sea as required, so that it will not be necessary to carry the water supply on board the torpedo.

One pound of motorite evaporates a little over two pounds of water, so that one pound of motorite produces the equivalent of three pounds of steam, for the products of combustion of the motorite mingle with the steam produced. The steam from the combustion chamber is conducted to turbines, or other engines or devices for propelling the torpedo through the water. By means of this system of propulsion, the range of the automobile torpedo can easily be doubled, while at the same time its speed can be increased 50 percent. The heavy air-flask will be done away with and will be replaced by a shell merely strong enough and heavy enough for structural rigidity.

This will enable the carrying of 160 pounds of motorite in place of the 130 pounds of air now carried, and as each pound of motorite will evaporate two pounds of water, we have available 480 pounds of motive fluid; and as steam and the products of combustion of motorite are much more efficient as a motive fluid per unit of weight than compressed air, it is safe to assume that we have available four times the energy now available in the 18-inch torpedo.



PROPOSED DESIGN FOR A SUBMERSIBLE TORPEDO BOAT WITH A DESTRUCTIBLE BOW.

Instead of carrying but 200 pounds of wet guncotton—the present charge—we should be able to carry 300 pounds of Maximite, which is practically twice as powerful per unit of weight as guncotton, while its density is 50 percent greater than that of guncotton, so that we should have a warhead easily three times as powerful as the present warhead.

The thing most needed at the present time is a torpedo boat capable of passing unscathed through the fire of quick-firing guns of a battleship in order to get near enough to reach her with certainty with torpedoes carrying a sufficient quantity of high explosives in the warhead to ensure her destruction when hit.

I am strongly of the opinion that the most effectual way of accomplishing this result is to construct a torpedo boat in the following manner:

Build the hull of the boat somewhat on the lines of the cigar-shaped automobile torpedo. Even a perfect counterpart of the torpedo in shape would serve the purpose well; but I would suggest a little greater vertical than horizontal diameter. In other words, I would build the boat a little more fish-shaped than the torpedo, and I would construct it so that it would be adapted to travel both upon the surface of the water and in a semi-submerged position, or rather, in a nearly submerged position. I would drive the boat with gasoline engines under normal conditions, and when going into action—that is to say, in making the run of attack—the boat would be in its nearly submerged position and would be driven by the combined power of the gasoline engines and motorite.

The gasoline engines will be provided with a shift gear, something like that employed on automobiles, so that under normal conditions—that is to say, when the boat is propelled along the surface of the water by the gasoline engines alone—the propellers will be driven at a slower speed, and a speed

* From a paper read before the American Chemical Society, New York, October, 1908.

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adapted to the speed of the boat thereby secured; but when going into action in a submerged position and traveling at possibly double the speed, the gear will be shifted so that the propellers will travel at a speed commensurate with the higher speed of the torpedo boat.

The boat will be provided with a top keel or fin a little thicker than a man's body across the shoulders at the rearward end, being narrowed down forward, and a conning-tower large enough for a man to stand erect. The front end of the superstructure will be sharp, and water will be thrown to right and left and will not obscure the forward view of the occupant of the conning-tower. The superstructure will be subdivided into small compartments, filled with cellulose. The partitions between the compartments will be thin sheet metal. The whole superstructure, except the conning-tower, will be very light and entirely dispensable, and can be shot away without actual damage to the boat itself. The superstructure will be for flotation purposes only, serving to tie the boat to the surface of the water, while the boat itself will be actually submarine. The superstructure will project above the surface of the water about a foot. The conning-tower will be protected by thin armorplate thick enough to resist the projectiles of small quick-firing guns, and there will be no danger of being hit by guns of a larger caliber.

It will be extremely difficult to hit either the superstructure or the conning-tower, even with small, quick-firing guns, for the conning-tower will not be more than two feet above the surface of the water, and will not exceed three feet in diameter, and will be moving forward at the rate from 40 to 60 miles an hour.

Of course, it will require stupendous energy to propel a submarine boat through the water at so high a rate of speed, and there is nothing available known to me except motorite which can supply the required energy. With motorite, however, we have easily all the energy that may be required for any desired rate of speed until the motorite is entirely consumed. Enough motorite can easily be carried to drive such a submarine boat at a speed of sixty miles an hour for a distance of 30 miles. This will be sufficient to overtake and sink any battleship that might be sighted. Of course, a speed of 45 miles an hour can be maintained for a much longer time, probably for an hour and a half, with the same quantity of motorite.

The Whitehead torpedo is in reality a sort of submarine torpedo boat, and what is true of it also holds true of the torpedo boat I propose. Of course, the keel and superstructure in the boat I propose would offer additional resistance, but on account of the larger size of the boat and its greater length and the enormous quantity of motorite that may be carried, we shall have available more than enough energy to make up for the increased resistance.

The boat will carry, say, a couple of torpedoes in the prow and launch them when getting within close range of a warship. These torpedoes should each carry at least 500 pounds of high explosive. It would be better if they carried half a ton each in the warhead.

I have shown how a torpedo boat may be made so that it may be safely run through the zone of fire of a battleship to launch its torpedoes at close range. I am, however, of the opinion that a far better way, and one which will be adopted in the near future, will be to employ a torpedo boat which shall itself constitute an enormous torpedo. It will be a species of ram; but instead of depending upon the steel prow for punching a hole in a warship, it will be armed with a ton of high explosive. The boat will be made, say, 300 feet in length over all, and 100 feet of the forward portion of the boat will be wholly dispensable and may be blown away without injury to the boat proper, the boat proper being but two hundred feet long.

The warhead of the torpedo boat will strike the battleship below its armor belt and the blast of the explosion will be inward and upward through the warship, while the reacting blast of the explosive charge will not be very severe upon the occupants of the torpedo boat. They will be hurled back by an enormous wave of water, but it will not be a quick, sharp, destructive blow, dangerous to the occupants of the boat or to the boat itself.

After torpedoing a warship, the torpedo boat, with its dispensable bow blown off, will still be in perfect trim to retreat and escape.

Of course, this torpedo boat will not supplant the automobile torpedo, for that will be employed in other evolutions; but for the direct run in upon a warship, this form of torpedo boat with a ton of high explosive in the warhead will be the main arm of naval service, for nothing could prevent one of these torpedo boats from selecting any battleship in any fleet and sinking it without a chance in a hundred of being prevented.

GUNBOAT BOILERS.

BY CHARLES S. LINCH.

The question is frequently asked, what is a low high-pressure boiler? In reply to these questions the attention of readers of this journal is called to the drawings herewith shown of the low high-pressure boilers installed on the Wilson Line steamboats. which are in service on the Delaware River between Philadelphia and Wilmington. This type of boiler is more frequently termed a "gunboat" boiler, for the reason that it is frequently used in gunboats or other shallow draft vessels where there is no room between the decks for the ordinary type of Scotch boiler. In the gunboat boiler the furnaces lead to a common combustion chamber, from which the boiler tubes extend to the back head of the boiler. Thus the construction of a gunboat boiler is very similar to that of a Scotch boiler, while the diameter is very much less.

The two Wilson line steamers, *Brandywine* and *City of Chester*, were built by the Harlan & Hollingsworth Corporation, at Wilmington, Del., the *Brandywine* in 1883 and the *City of Chester* in 1888. The *Brandywine* is 177½ feet long, with a molded beam of 25.1 feet, and she is driven by a single four-and-aft compound engine, having cylinders 21 and 42 inches in diameter, with a stroke of 24 inches. The boilers originally installed on this boat were in service until 1905, when it was found that the furnaces and combustion chambers would have to be replaced, although the shells were in perfect condition. It was found that the cost of tearing the old boilers out and rebuilding them would be more than the cost of entirely new boilers, and, therefore, new ones were built from similar designs. Plans for these new boilers are shown in Fig. 1. The steam pressure carried on the old boilers was 120 pounds, but when the new boilers were installed this was raised to 150 pounds, and the diameter of the high-pressure cylinder of the engine was reduced to 21 inches, making the ratio of cylinder capacities 1 to 4.

This boat has proved remarkable in many ways. In ten months she recently ran 47,750 miles with a cost for machinery repairs of only 5 cents, this expenditure being for a ¼-inch close nipple. During the summer three round trips are made per day, and in the winter one and a half trips are made daily. Her performance in the ice is considered remarkable. as it has frequently happened that when the ice boats have been unable to cut their way out the *Brandywine* has come through.

The *City of Chester* is 197 feet long over all, with a molded beam of 28 feet and a total beam outside the guards of 40 feet. She is equipped with one three-cylinder triple-expansion engine, with cylinders 18½, 27 and 42 inches in diameter and

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a stroke of 24 inches. The two boilers which were originally installed on this boat when she was built in 1888 are still in service, and are still carrying the steam pressure of 160 pounds for which they were originally designed. In 1896 the combustion chambers of these boilers were increased 6 inches in length, and suspension furnaces of the Morison type were substituted for plain furnaces. Corresponding to the change in length of the combustion chamber the old tubes were reduced 6 inches in length and were replaced; but, up to the present time, only about one-third of the old tubes have been renewed.

The boilers of both the *Brandywine* and *City of Chester* are operated under forced draft, which is maintained by steam jets of the Bloomsburg type. A Bloomsburg circulator is also used in each boiler. The *Brandywine* is now equipped with a Riley feed-water heater, while the *Chester* takes her feed direct from the filter box. Each boiler is provided with main and auxiliary feed, the main feed pump being a 7 by 4½ by 8-inch Worthington duplex, and the auxiliary feed by injector.

The fuel consumption of both the *City of Chester* and the *Brandywine,* under forced draft, is 35 pounds per square foot of grate area per hour. Under natural draft it is from 20 to 22 pounds.

At the end of the season, when the boilers are opened, the interior is invariably found to be in perfect condition, without the slightest trace of grease, mud, scale or, in fact, any sign of deterioration. This fact accounts for the long life and continued efficiency of these boilers, and is due to the constant attention which they receive by the engineers in charge, since the class of work which these boats do in both summer and winter does not permit the boilers to be opened for months at a time. The machinery in these boats has proved as efficient as the boilers, which is shown in the instance of the packing in the high-pressure and low-pressure stuffing-boxes of the *Brandywine,* which was not touched for twenty-three years, while the piston rods are in perfect condition without a scratch upon them. Further evidence of the class of work turned out when these boilers were installed is shown in the accuracy of the steam gages, which have been in place ever since the boats have been in existence, and which have maintained their accuracy to the present day. These gages were manufactured by the American Steam Gauge & Valve Manufacturing Company, of Boston, Mass.

Although the requirements which these particular boilers are forced to meet are exacting, nevertheless their superiority over any other type of boiler for such service has been well demonstrated. It would be impossible to install Scotch boilers in these boats, as they would encroach upon the deck space which must necessarily be reserved for freight. A careful study of the drawings will serve to show that these boilers are not only strong and well built, but that the steam space is large as compared to that of many Scotch boilers; that is, the ratio of the volume of the steam space to the volume of the high-pressure cylinder is large. Trouble from leaky seams has not been experienced with these boilers, due probably to the fact that water circulators are fitted. The frequent claim that the low high-pressure or gunboat type of boiler is an inefficient steam generator and a poor design to use has been entirely discredited in the case of these two boats.

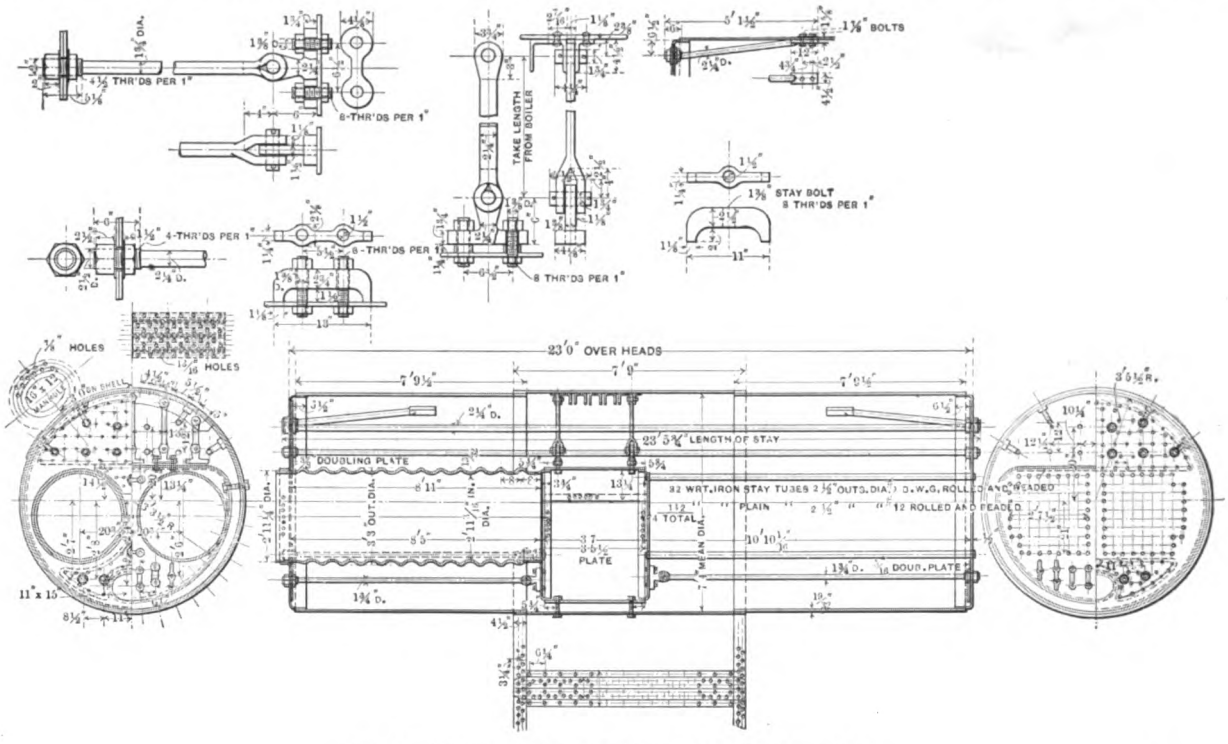

FIG. 1.—DETAILS OF GUNBOAT BOILERS ON THE BRANDYWINE.

BOILERS OF THE "BRANDYWINE."

The boilers of the *Brandywine,* details of which are shown in Fig. 1, are 23 feet long, 7 feet 4 inches in diameter, built for a working pressure of 150 pounds per square inch. The total heating surface is 1,405.9 square feet, divided as follows: Tubes, 1,234 square feet; furnaces, 98.4 square feet; combustion chamber, 58.5 square feet; tube plate, 15 square feet. The total grate surface is 39.5 square feet, making a ratio of heating surface to grate area of 35.5 to 1. The area through the tubes is 703 square inches per square foot of grate area.

The shell of the boiler is in three courses, and is 19/32 inch thick. The circular seams are double-riveted lap joints, with ⅞-inch rivets spaced 3¼ inches between centers. The longitudinal seams are triple-riveted butt joints, with the outside straps ½ inch thick and 9 inches wide, and the inside straps 14¼ inches wide and ½ inch thick. The rivets are ⅞ inch

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diameter, and are spaced 3⅛ inches and 6¼ inches between centers. The percentage strength of this joint, as compared with the solid plate, is 85.8.

Each boiler has two corrugated furnaces, 3 feet 3 inches outside diameter, 8 feet 11 inches long, 13/32 inch thick; and

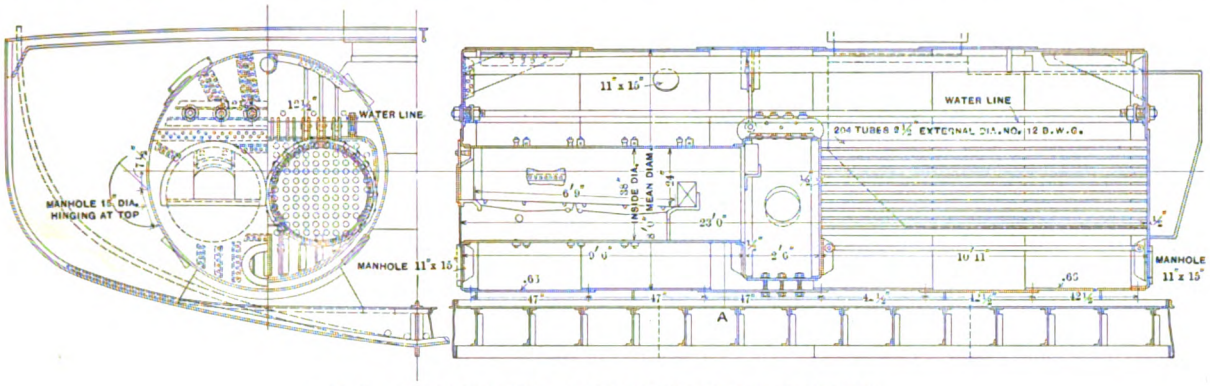

FIG. 2.—ONE OF THE GUNBOAT BOILERS ON THE CITY OF CHESTER.

174 2½-inch outside diameter tubes. Thirty-two of the tubes are wrought iron stay tubes, No. 9 B. W. G.; the remaining 142 are wrought iron plain tubes, No. 12 B. W. G. The distance between tube plates is 10 feet 10 1/16 inches.

The front head of the boiler is a single sheet, ½ inch thick, flanged inwards to join the shell and outwards for the furnace mouth. The portion of the head above the furnace is reinforced by a ⅜-inch doubling plate, and the portion below the furnace by a 5/16-inch doubling plate.

The heads of the boiler are stayed by 2¼-inch through stay rods and 2¼-inch diagonal stays. The lower part of the heads is braced by 1¾-inch stay rods, fastened to the combustion chamber by two 1⅜-inch bolts, as shown in the details, Fig. 1. The staying of the combustion chamber crown sheet is accomplished by means of sling stays to the shell of the boiler, spaced 6 inches longitudinally and 6½ inches across the boiler. These stays are fastened to the crown sheet so as to leave a clear water space of 1¼ inches all over the sheet.

BOILERS OF THE "CITY OF CHESTER."

The two boilers of the *City of Chester* are each 23 feet long and 8 feet diameter. Each boiler has two plain circular furnaces, 38 inches inside diameter and 9 feet 6 inches long, with a single combustion chamber, 2 feet 6 inches deep and 204 2½ inches outside diameter tubes of No. 12 B. W. G. thickness. The total heating surface in each boiler is 1,644.5 square feet, divided as follows: Flues, 109.5 square feet; combustion chamber, 58.5 square feet; tubes, 1,457.5 square feet; back tube sheet, 19 square feet. The grate area of the boiler is 42.75 square feet, therefore the ratio of heating surface to grate area is $\frac{1,644.5}{42.75} = 38.5$ to 1. The flue area through the tubes is 5.8 square feet, and the ratio of the area of the grate surface to the area through the tubes is $\frac{42.75}{5.8}$, or 7.37 to 1.

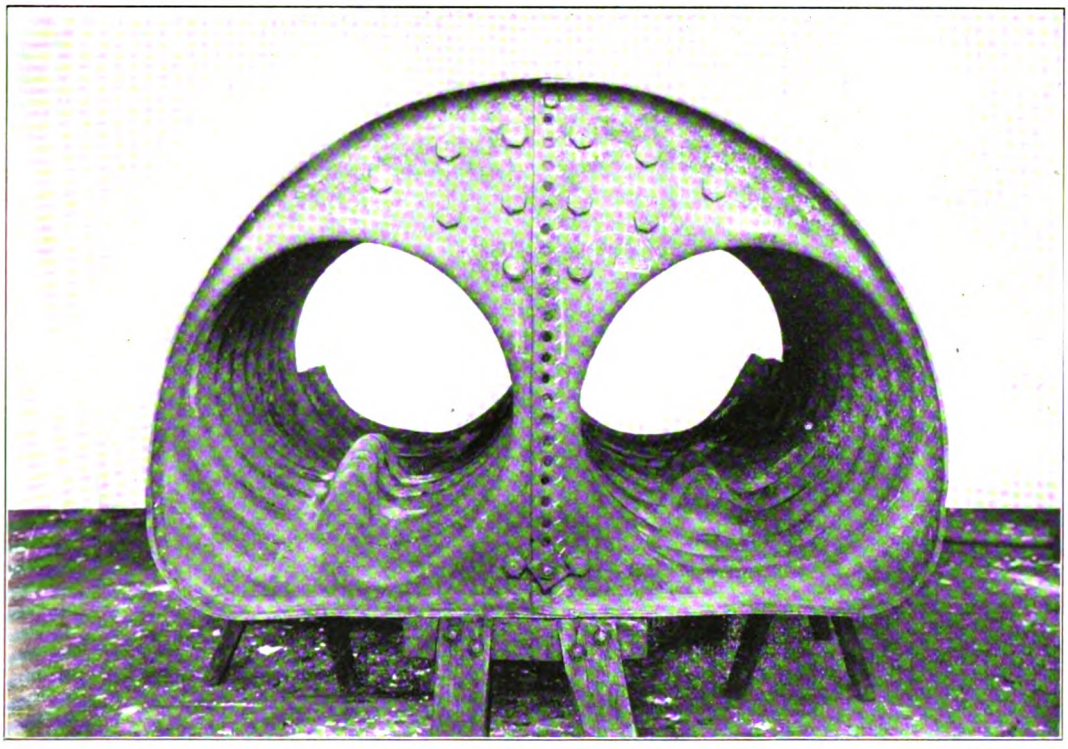

FIG. 3.—RESULT OF LOW WATER IN THE NEW BOILERS OF THE STEAMER BRANDYWINE.

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The boilers were designed for a working pressure of 160 pounds per square inch. They were built of six courses of steel plate .66 inch thick. The circular seams are double-riveted lap joints, fastened with 1-inch rivets spaced 3½ inches between centers. The longitudinal seams are triple-riveted butt joints with steel butt straps, ½ inch thick, fastened with 1-inch rivets spaced 4½ inches between centers. The front head is made in two sections, the furnace sheet and the upper sheet. These are fastened together with a lap joint by ⅞-inch rivets spaced 2½ inches. Both sheets are ½ inch thick, and the furnace sheet is flanged inwards at the furnace mouth.

The furnaces themselves are plain cylindrical tubes of ½-inch plate, with single-riveted lap longitudinal joints, fastened with ⅞-inch rivets spaced 2½ inches between centers. The furnaces are stayed by means of iron rings, 3 by 1½ inches half round at the top and flat on the bottom. On the upper part of the furnace, above the grate bars, these reinforcing rings are separated from the furnace by thimbles around the rivets 1¼ inches long, leaving a clear water space outside the furnace. On the bottom of the furnace, however, these reinforcing strips are riveted fast to the plate without the intervening water space. There are four reinforcing rings on each furnace. The grates are each 6 feet 9 inches long, and terminate at a soapstone fire wall. A similar wall is also placed at the top of the furnace at the entrance to the combustion chamber, in order to protect the crown sheet thoroughly.

The combustion chamber tube plate is ½ inch thick, and is flanged inwards to join the wrapper sheet. The crown sheet is stayed by the ordinary form of girder crown bars, carrying stay-bolts 1⅜ inches diameter outside the threads and spaced 6 inches apart. The girders themselves are spaced 6¼ inches center to center. Each girder is composed of two ¾-inch plates, 6½ inches wide. The sides and bottom of the combustion chamber are supported by 1⅜-diameter threaded stay-bolts, spaced 6¼ inches circumferentially and 6¾ inches longitudinally. These stays are fitted with nuts, both outside the boiler shell and inside the combustion chamber.

The heads of the boiler are stayed partly by means of through stay rods of double refined iron, 2¼ inches in diameter, and partly by gusset stays of ⅝-inch plate, 10¼ inches wide, riveted to the shell and to the head by double 5 by 3 by ½-inch angle bars. Details of the method in which the through stays are fastened to horizontal angle bars on the heads are shown in the drawing.

ACCIDENT TO THE BOILERS OF THE BRANDYWINE.

On Sept. 5, 1908, while the chief engineer of the *Brandywine* was off duty, the assistant, through negligence and neglect, allowed the water to become low in the boiler with the result that the crowns of the furnaces came down, as shown in Fig. 3. No deposit of any kind was found in the boiler, so that the only reason that could be assigned for the accident is low water. At this time the feed pumps were at the shops being overhauled, and hence the injector was the only means which could be relied upon for feeding the boiler. An examination of the water-glass fittings was made, and the bottom was found clogged with mud, while the top connection contained pieces of glass, which prevented it from functioning. The engineer on watch admitted having renewed the glass without cleaning out the connection. Taking into account the surface, which was at a high temperature at the time of the accident, if water had been put into the boiler it is probable that the safety valves and engines would not have taken or reduced the volume of steam to a point to prevent rupture. The material of which the furnaces were made was of splendid quality and showed high physical properties.

ANCHORS.

BY J. M. BULKLEY.

The constituent parts of the common anchor, as it is familiarly known, are the shank, the stock, the ring, or shackle, and the two curved arms, or crown, with their flukes. These parts were mostly of solid iron, except the stock, which was generally composed of two cheeks of wood, fastened together with hoops or tree-nails, and sometimes of metal. An English shipbuilder named Hawks secured a patent in 1823 for an improvement upon the then existing form, which consisted in forming a groove down the center of the shank, for the cable to pass through, and to which a chain was to be attached to the ring at the end.

Capt. Rodgers, of the Royal navy, devised a compound anchor in 1828, upon which he was granted a patent. It is inconceivable in these days that such a contrivance as is described could have received even passing consideration. It consisted of a hollow shank of iron, which was to receive a core of wood, and which, with the stock, was composed of several pieces bolted together.

The best anchors of the solid description were forged from "bundled" or scrap iron. For the introduction of an improved method in preparing the material credit was given to Henry Cort, the person who led the way to the practice of puddling in the conversion of cast into malleable iron. The forging of anchors by his method, or any other under the best circumstances, was a laborious business, even when a hammer of 800 or 900 pounds weight was employed.

With the general adoption of the solid iron or steel anchor as the most useful, there have not occurred many changes until the appearance some years ago of the stockless anchor with jointed arms, that is, joined to the shank by a hinge attachment allowing the arms to adjust themselves to the conditions as they were found at the bottom and to generally secure a firm hold.

The anchor of the present day is naturally a vastly different affair as to size from those in use seventy, or even twenty-five, years ago. The anchor now used on the largest battle ships has a maximum weight of about 17,000 pounds.

The object of the stock, which forms a cross with the shank and at right angles with the crown, is to compel the engagement of the flukes with the ground; obviously, with the fixed wooden stock an anchor of ordinary form is an awkward piece of equipment to "stow" on board, consequently the crown and shank were laid flat on a "bill board," leaving the stock in a vertical position over the bows of the ship. The adoption of the iron stock made it possible to arrange it so it could be slipped through the eye of the shank and the whole more conveniently stowed on board.

The commonest form of anchor, aside from the familiar conventional form with fixed stock, up to the advent of the now almost universal "stockless," was the Trotman. In this form the crown, with its flukes, was hinged or pivoted to the shank. This allowed of deeper penetration, the angle of movement being fixed by the point or "bill" of the upper fluke coming in contact with the shank. This anchor was almost invariably used on steamships until recent years.

With all these forms much time and labor were involved in "letting go" and in heaving up and getting on board. In narrow channels, and when getting inshore, the anchor was almost valueless unless previously got overboard and ready for instant letting go. It also occupied considerable valuable space on board and involved a lot of additional tackle and lashing.

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The stockless anchor avoids all these difficulties. Its construction may be seen in almost any picture of a modern ship, from which it will be noted that the shank is pulled up into the "hawse-pipe" entirely within the hull, and only the flukes and crown are outside, lying snugly against the bow of the ship. With the steam windlasses now universally employed on modern sailing ships, the anchor is always ready for letting go; it is not even necessary to turn on steam. The anchor is held in place by a powerful brake on the windlass, and with the releasing or easing up of this brake the anchor shoots out of the hawse-pipe, running out the chain over the windlass.

For ships that lie at anchor continually, such as lightships, and must ride out the heaviest gales, swinging to every shift of wind or tide, the "mushroom" anchor is invariably employed, because no matter how the ship swings, it always retains its hold and does not break ground. Ordinary anchors suffer much from breakage under these conditions, and also as each time the anchor breaks ground it must drag, although it may be only a few feet, before it "trips" again, the ship may ultimately get considerably off her station. The advantages of the mushroom are thoroughly recognized, but as it has always been made with a rigid shank it is practically impossible to stow it, and it is therefore only employed under water.

The now common stockless anchor has some serious disadvantages. The hawse-pipe must be so much larger in order to house the shank that it leaves a large opening for the entrance of water when the ship is pitching. To avoid this, "lucklers" must be fitted as closely as may be about the chain at the inner end of the pipe, but they are never very tight, and they must be got clear before the anchor can be let go. Besides, the flukes and crown, projecting beyond the hull plating, form, from their shape, a savage weapon in case of two ships touching each other ever so lightly, as frequently happens in crowded harbors, and many collisions would have been comparatively harmless but for the projecting anchor nipping along the side of the other ship. The ship, herself, is sometimes damaged as a consequence of these anchors fouling wharves, etc.

The most recent development of the anchor, then, is to retain the stockless feature, with its convenience in handling and stowage, the holding power and anti-fouling qualities of the mushroom, and to present a smooth contour outside the ship, which will reduce damages from contact with wharves or other ships, and this has been done in an anchor in which the mushroom crown is made with a ball and socket connection to the shank, allowing it to assume any angle inferior to 70 degrees.

THE FASTEST SHIPS IN THE WORLD.

MERCHANT VESSELS

In a previous article on high-speed vessels we dealt solely with warships of the cruiser and destroyer types, and showed how, while length had increased in proportion to the speed, the attainment of very high relative speeds involved such an abnormal proportionate increase in space and weight occupied by the machinery that the fighting power was reduced to a minimum. (See Table III., page 57, February, 1908.)

We now propose to deal with fast mercantile vessels, and in their case the commercial necessity of profit-earning absolutely precludes the phenomenal speeds attained by warships. Armour and armament correspond largely to cargo and passenger-carrying capacity, and if the machinery is increased for a gain in speed, fighting power or dividends must obviously be sacrificed.

Retaining the basic standard of $\frac{V}{\sqrt{L}}$ as a measure of speed, and considering only the fastest merchant vessels in point of *absolute* speed, we must confine investigation to the three following classes of ships:

I. Channel steamers.
II. Mail steamers: (*a*) Atlantic traffic.
(*b*) Other services.
III. Intermediate vessels.

Channel steamers are in a class entirely by themselves, not only on account of the shortness of their voyages, but also on account of the fact that they are run in conjunction with or owned and supported by the principal railway companies and are run as an adjunct to these services, and not as independent profit-earning companies. Most of these lines make passenger carrying their chief consideration, and this, in addition to local considerations, of size of ports and dock dues, affects the design to a very marked extent. There are some twenty different lines or services running between England and Ireland, Scotland or the Continent; the shortest run is 21 and the longest 210 miles. In nearly all cases, except the Isle of Man service, the length of ship has hitherto been strictly limited—for the Newhaven and Dieppe vessels 280 feet is a maximum—and, as fierce competition stimulates the ever-increasing demand for speed, it has only been obtainable with the channel vessels owing to their not being dependent on cargo carrying. Absolute speeds have increased considerably in recent years, due largely to the general application of the steam turbine, and, with the exception of the large Cunarders, the fastest merchant vessels are found in this class of ship. Table I. shows the names and services, with the leading dimensions, of some of these vessels:

TABLE I.

Vessel.	Date.	Service.	Length, Feet.	Speed.	$\frac{V}{\sqrt{L}}$	I. H. P.	Displacement.
Manxman	1904	Heysham—Douglas	330	23.00	1.266	9,000	2,270
Londonderry	1904	Heysham—Belfast	330	22.29	1.228	7,200	2,150
Viking[1]	1905	Liverpool—Douglas	350	23.53	1.258	12,000	2,400
Princess Elizabeth[1]	1905	Ostend—Dover	344	24.06	1.295	11,000	2,000
Dieppe[1]	1905	Newhaven—Dieppe	280	21.6	1.29	6,500	1,360
St. George[2]	1906	Fishguard—Rosslare	350	23.00	1.23	11,000	2,500
Viper	1906	Ardrossan—Belfast	325	21.5	1.194	6,500	1,600
Empress[3]	1907	Dover—Calais	323	22.9	1.274	9,000	1,870
Connaught[3]	1896	Holyhead—Kingstown	360	23.5	1.24	9,000	2,180
Le Nord	1898	Dover—Calais	343	21.5	1.17	7,000	1,850
Anglia[3]	1900	Holyhead—Dublin	330	21.2	1.165	7,170	2,340
Arundel	1900	Newhaven—Dieppe	277	21.0	1.264	5,600	1,310
Alberta	1900	Southampton—Havre	270	19.9	1.212	5,350	1,530
Duke of Connaught	1902	Fleetwood—Belfast	315	20.1	1.13	5,800	2,210

[1]One sister ship of similar speed under construction. [2]Three sister ships also in service. [3]Four sister ships also in service.

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The first eight are all turbine steamers, while the older six vessels in the second half of the table have reciprocating twin-screw engines, with the exception of *Le Nord,* which has paddles. The *Connaught,* built eleven years ago by Lairds, of Birkenhead, was always an exceptional vessel, and certainly one of the finest and fastest twin-screw channel steamers ever built. The rise in relative speed in recent years is clearly indicated by the increasing speed-length ratio, which places the *Princess Elizabeth, Viking* and *Empress* types distinctly above the *Amethyst* in Table III. (page 57, February, 1908). It is worth while remarking that none of these vessels would be possible with reciprocating engines. The light weight of their turbine machinery, together with the possibility of obtaining efficient propellers for such light drafts of water—only 9 feet 6 inches in the *Princess Elizabeth*—has rendered higher speeds possible on the same length of vessel—no light advantage for lines that exist on passenger traffic.

The case of large Atlantic liners is somewhat different. The conditions of ocean-going and of long voyages involve a proportionately heavier hull and greater regard for the coal bill; hence the reduction necessary in proportionate weight of machinery to displacement. Whereas it is found possible to put 3.5 to 5.5 horsepower per ton of displacement into a channel steamer, in fast Atlantic liners this figure is reduced to 1.8 in the *Mauretania,* 1.62 in the *Kaiser Wilhelm* II., and 1.52 in the *Deutschland,* while in the older vessels it is even less. In even the fastest vessels of the Atlantic intermediate type it has fallen to 0.6 in the *Carmania;* to under .5 in the *Baltic,* and to 0.4 in the *Saxonia.* The speed-length ratio of the fast liners has not risen much in recent years: since the *Campania* came out in 1893 the increase has been inappreciable, as the following table shows:

TABLE II.

Vessel.	Date.	Length.	Speed.	$\frac{V}{\sqrt{L}}$	Horse-power.
Campania	1893	600′ 0″	22.0	0.9	30,000
St. Louis	1895	535′ 6″	21.08	0.91	21,000
Deutschland	1900	662′ 9″	23.5	0.913	36,000
Kaiser Wilhelm II...	1903	683′ 0″	23.5	0.9	42,000
Provence	1906	575′ 0″	22.0	0.917	30,000
Mauretania	1907	760′ 0″	25.5	0.925	70,000

Vessels of 16 and 17 knots speed are not now considered fast by the general public, but for long-distance services, such as from Madeira to the Cape of Good Hope, the enormous amount of coal that has to be carried becomes a serious item, and a speed of 17 knots is high for a distance exceeding 4,000 miles. Economic propulsion, therefore, becomes most essential, and a speed-length ratio of about 0.65 to 0.75 is more usual. Intermediate vessels of the *Saxonia* type on the North Atlantic approach the lower figure, while the *Baltic* class are even below it.

The question of what are the fastest vessels in the world can only be answered by introducing qualifying conditions. On a measured-mile trial or a short burst of a few hours' duration there is no doubt that the new oil fuel turbine-driven destroyers of the Royal Navy would give superior speed results to anything else, and even in fairly rough weather they would still prove far faster than the channel steamers. They are not designed for long-distance work; in fact, they cannot be, and it is one of the many penalties paid for high speed. Relatively to their length they are abnormally fast. But in really rough weather their low freeboard and short absolute length compared with the big liners would be a serious handicap, and it still remains unproved as to whether they could get away from the *Mauretania* and *Deutschland* in a heavy sea. Their light construction would make it a risky business to run them fast in really rough weather; certainly it was shown to be a very dangerous performance with the old 30 knotters of ten years ago.

The *Scout* class of cruiser—370 feet long and 25 knots—can only be called fast relatively to length. Not fast enough to catch destroyers except in rough weather, they are equally unable to get away from the *Mauretania* in smooth water, and in a very moderate sea their speed sinks below that of the German liners.

For war purposes, the gigantic new cruisers of the *Invincible* type will probably be found to be the fastest seagoing ships afloat. Their speed-length ratio is low compared even with the *Encounter* class, while their great absolute length and size will enable them to maintain their speed in weather in which it would be risky to drive even the *Tartar or Cossack.* The cruisers of this type come midway in point of speed-length ratio between the channel steamers and Atlantic liners.

What the future of high-speed ships will be it is hard to say. Already the new destroyers are beginning to provide unsuspected phenomena, and the speed of all types is rapidly increasing. That there will be a distinct increase in speed on a given length before long is quite certain; the reason will be the rapid improvement in the propelling machinery. The turbine has already done a great deal for the channel steamer, but it is rather to improve boiler performance that we must look for progress in the Atlantic liner. Oil fuel has given such remarkably good results in the British destroyers that its adoption for large vessels is only a question of time. There is little doubt that Yarrow type boilers and oil fuel in the large Cunarders would, in the same space and on the same weight, give about 20 to 25 percent more steam corresponding to an addition of between one and two knots to the speed. But would it pay commercially? Would the fuel be cheap enough and would the boilers be as durable? The profit-and-loss side of the question supplies the answer in all cases. Whether it be speed or fighting power for warships, dividends or speed in the merchant marine, the commercial conditions govern each case, and their diversity has supplied us with innumerable types from which to gather experience.

THE DEVELOPMENT AND PRESENT STATUS OF THE EXPERIMENTAL MODEL-TOWING BASIN.

BY H. A. EVERETT, S. B.

Establishment of the North German Lloyd Tank at Bremerhaven, Germany.

In 1899 the North German Lloyd Company had towed at Spezia the model for one of their projected express steamers, and the results obtained produced such a good impression that it was decided to construct an establishment of their own for similar work. This was completed in February, 1900, the tank being 540 feet long by 19.7 feet broad by 10.5 feet deep. The steel carriage which spans the tank is electrically driven by two motors. It weighs 11,000 pounds, and has a clear run of 475 feet, with a speed range of from 2 feet to 1,000 feet per minute. The models are of paraffine, 15.5 feet in length, and the towing equipment for both hull and propellers is patterned after Froude's. This establishment is in very close connection with the German government, and has done some naval work for it besides, of course, that in connection with their own express steamers which belong to the Naval Reserve. Water from the River Weser supplies the tank after passing through filters.

The Berlin Tank.

The tank at Berlin, Fig. 16, is located in the "Thiergarten," or park, in Charlottenbourg, one of the outlying districts, and was commenced subsequent to an appropriation of 378,000 marks ($94,500) (£19,405) by the German government in 1901, and finished the following year. The control of the tank is rather peculiar, as it is used exclusively by the Navy Department for certain months of the year and by the Tech. Hochschule at other times. The tank itself is of concrete, 558 feet

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maximum length by 34.5 feet breadth, and is 11.5 feet deep; there is a clear run of about 480 feet, but allowing for starting and stopping the carriage there is left about 250 feet to 260 feet for full-speed runs. The maximum speed of the carriage is about 1,400 feet per minute, and models up to 23 feet can be handled. The carriage has been constructed in two sections (see Fig. 15); the driving carriage and the instrument carriage, in order to minimize the effect of the wheel jar on the recording apparatus. The driving carriage is a large steel structure, 39 feet long, electrically driven by two motors, and has a span of nearly 20 feet. Inside the rectangle formed by the four wheels of the driving car (see Fig. 16) is the smaller rectangle formed by the wheels of the instrument car, which is coupled directly to the former, and which travels on the same tracks. The track on which the cars travel is supported on pillars at intervals of about 6 feet, and considerable discussion has arisen concerning the effect of these local rigid spots in the track upon the recording apparatus. Those in charge of the tank state that no trouble is experienced, and that the matter was thoroughly tested out in the tank at Bremerhaven with a similar arrangement. The

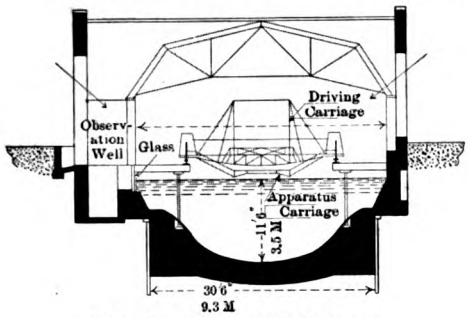

FIG. 15.—SECTION THROUGH C-D.

section of the tank is somewhat similar to that at Washington (see Fig. 15), with sloping sides and submerged ledges at the top, but it has provision for building in a smaller temporary section, so that the influence of depth and various canal cross-sections may be studied, this last being of especial interest in Germany. The resistance and propeller mechanisms are of the general type of Froude's, as already described. It was originally intended to obtain the water for the tank (3,700 cubic meters) from the nearby canal, but later it was decided it would be better to take from artesian wells, which has been done. Paraffine is the material used for models, and gas is used for melting it. The head end of the tank building is directly under the Berlin Elevated Street Railway, and it is reported that the vibrations from passing trains sometimes prove troublesome. Half-way down the length of the tank a glass plate, nearly 50 feet long, is fitted in the side, to investigate and photograph the wave-formation of the passing model. The propeller mechanism is designed for one, two or three shafts, and will take single or multiple screws on each shaft; it is, moreover, capable of testing them at any desired revolutions up to 3,000 per minute, this wide range being thought desirable for investigating turbine propellers. In line with this is the propeller-measuring apparatus, which permits of measuring the model propellers to 1/20th of a millimeter. The nominal head is Prof. Oswald Flamm.

The Tank at the Clydebank Shipyard of John Brown and Company, near Glasgow

This is the most recent tank (Fig. 17 and Plate II.), and the second privately constructed in Great Britain. It is 445 feet long by 20 feet broad by 9 feet deep, and has 400 feet available for towing. It is of concrete, rectangular in section, with the docks and trimming tanks at one end and a sloping beach, 25 feet long, to assist in breaking up the waves at the other end. The building is of brick, and contains

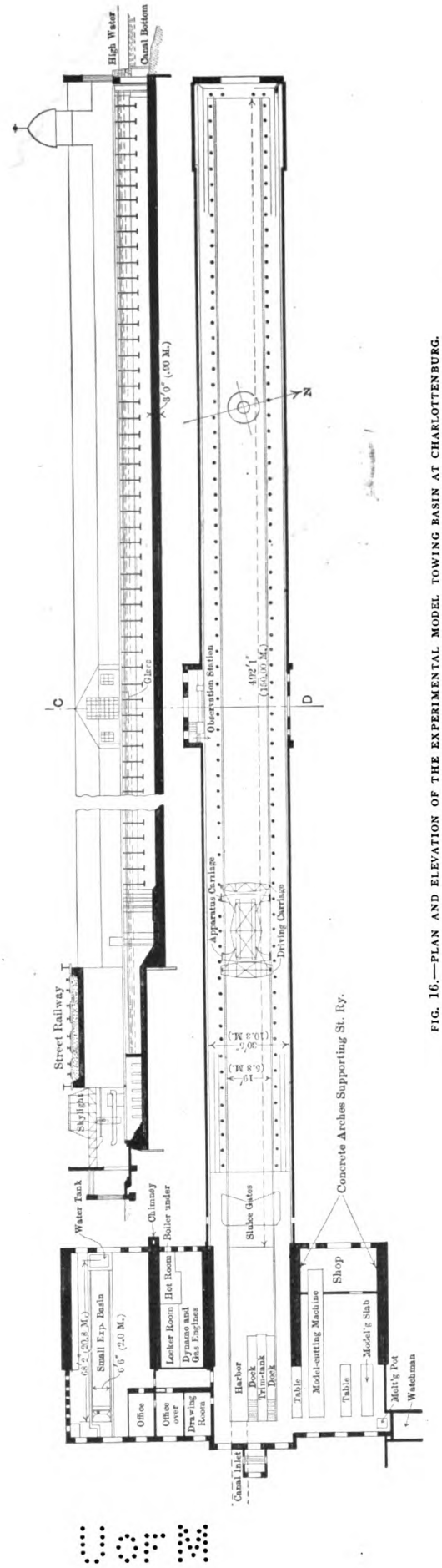

FIG. 16.—PLAN AND ELEVATION OF THE EXPERIMENTAL MODEL TOWING BASIN AT CHARLOTTENBURG.

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the drafting, tracing and record rooms and the superintendent's office, and in an adjoining building is the model-making department. The models are of paraffine, with a standard length of 15 feet, though this is sometimes departed from. The building is heated in winter by hot water. The fairing up lines to large scale, to eliminate the error caused by the shrinkage and expansion of paper with varying atmospheric humidity. The tanks for melting the paraffine, together with the casting box and the cutting machine, are in the hall at the head, or north end, of the tank. For experimental work

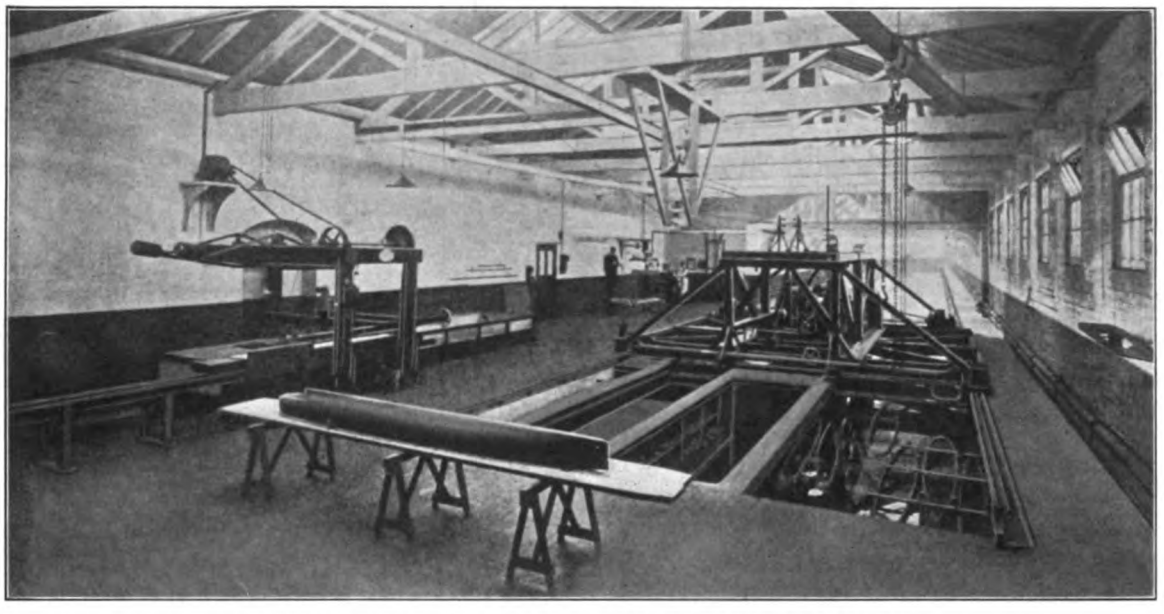

FIG. 17.—INTERIOR OF THE TANK AT THE CLYDEBANK YARD OF JOHN BROWN & CO.

towing carriage is a light, wooden trussed structure (see Fig. 17), reinforced by metal, which spans the tank, and weighs, exclusive of propeller mechanism, 2 tons. It is electrically driven (the only one so driven in Great Britain) by two 6-horsepower motors, and has a speed range up to 1,000 feet per minute. The resistance and propeller mechanisms are after Froude's pattern (see Fig. 3). In the drawing office a large marble slab (20 feet by 4 feet 6 inches) is used for

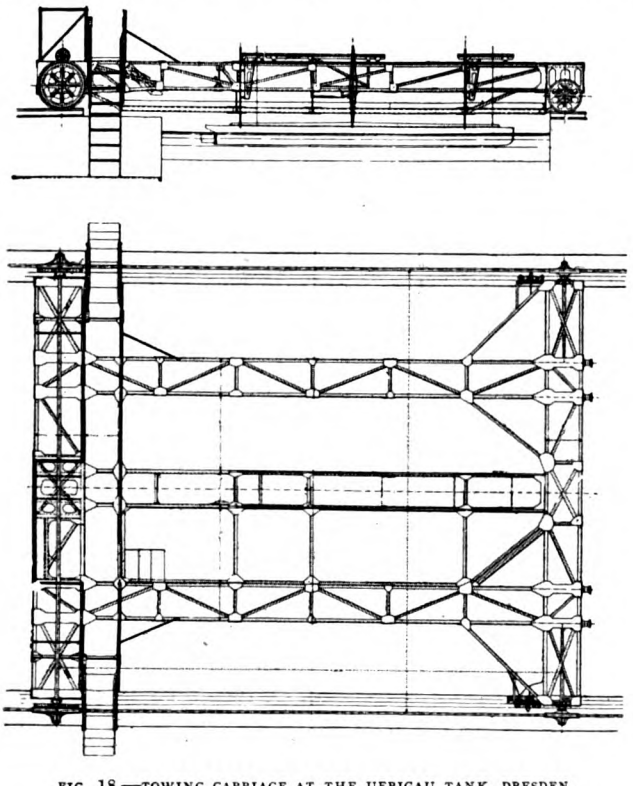

FIG. 18.—TOWING CARRIAGE AT THE UEBIGAU TANK, DRESDEN.

the following force is employed: Draftsmen, 6; experimenters, 3; mechanics, etc., 4; giving a total of 13 men. The tank was completed November, 1903, and is in charge of Mr. W. J. Luke.

The New "Uebigau" Tank near Dresden, Germany.

As the new tank at Uebigau, near Dresden, the newest of the three German tanks, is the direct outgrowth of the old Uebigau tank, we will describe the two together. The first one was built by the Elbe Steamship Company "Kette" in 1891-2, and was established primarily to obtain information for the design of river steamers. Although not completed until this date it had been originally projected as far back as 1883, and the carriage and measuring instruments completed the following year. The tank itself, however, languished until the company obtained the contract for two swift steamers to be fitted with Zeuner's turbine propellers, and this furnished the incentive which resulted in the completion of the tank in 1892. It was built of brick, and was 206 feet long by 24.6 feet broad by 4.5 feet deep, with sloping sides and a flat bottom (see Plate I.). The carriage was a small affair of less than 2 feet span, drawn by a man, and provided with a pull dynamometer and a speed and time device. Later electricity was tried for motive power, but was discarded on account of its non-uniformity of speed. The tank was not roofed over, and for eight years was the only one of any sort in Germany, and served both navy and merchant marine. Soon after its completion, on the suggestion of the government, it was lengthened to 394 feet, roofed over and the tracks suspended from the roof. After that the government paid a yearly indemnity and received in return extensive use of the tank, and it served also as an experimental laboratory for the Dresden Tech. Hochschule.

Agitation for a new tank was kept up for some time, and finally resulted in a grant from the Saxon government, with the provision that the new establishment should be used by the Tech. Hochschule at Dresden as an experimental station and laboratory similar to the arrangement at Berlin with the Tech.

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Hochschule at Charlottenburg. The new tank was begun 1903 and ready for work in 1904 (Plates I. and II.); it is 312 feet long by 21.0 feet broad on the water surface by 11.3 feet deep, of concrete, as shown in the cut, and embodies some innovations, notably the towing dynamometer. The water is furnished from a spring, pumped in by a pulsometer, and the tank empties directly into the River Elbe. The tank is provided with supports, as in the case of the Berlin tank, to permit of false sides and bottom being built in for investigation of the effect of depth and various canal cross sections on the resistance.

Half-way down the length of the tank is the observation and photographic station for wave profile and similar work. There is a large plate-glass window inserted in the side of the tank and a tunnel which goes completely under it. This latter is provided with round plate-glass windows, similar to ships' deadlights, in its roof, so that the model can be observed or photographed from any position above or below as it is towed by.

The carriage (Fig. 18) is of steel-latticed girders, three fore and aft and two across, and has a length of 29.6 feet and a span of 23 feet. It is of 5½ tons weight, electrically driven, and has a speed of from about 10 feet to 1,000 feet per minute. It has the unique feature of being controlled from a stationary platform at one end of the hall. The towing mechanism is somewhat different from those already described, as will be seen from the diagrammatic sketch (Fig. 19). "*M*" is a small electric motor, that keeps such a tension in the dynamometer spring *I* that the vertical towing rod *A* is maintained clear of

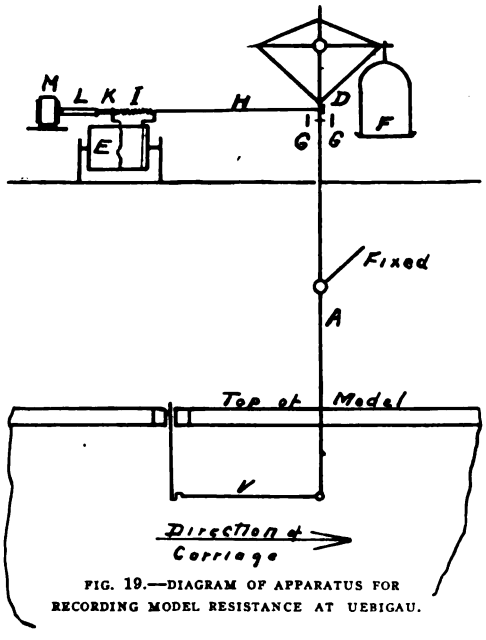

FIG. 19.—DIAGRAM OF APPARATUS FOR RECORDING MODEL RESISTANCE AT UEBIGAU.

the two contact points *G G*, when the pull of the model is shown by the distortion of the spring plus the weights in the scale pan *F*. The contacts *G G*, which govern the tension in the spring by the motor, are only a very minute distance apart (1 mm.), only enough to keep the current from leaping across, and so the system is in equilibrium practically all the time. The propeller mechanism also follows the same ingenious line (see Fig. 20) in the part for recording thrust. The propeller is carried by the frame *ABCD*, which is free to swing in a fore and aft direction, and is driven by shafting, with universal joints and bevel gears passing through the frame. The operator knows approximately what the thrust is going to be, and places weights in the scale pan *F* to take it nearly up, the rest is taken up by the motor regulated spring *S*, as in the case of the towing mechanism above. When the lever *JEL* is pulled out of its vertical position it strikes one of the contacts *G*, which starts the motor *M;* this, by means of the screw and sleeve *K*, extends or compresses the spring *S*, until the lever *JEL* is drawn back to its vertical position when the system is in equilibrium, and the thrust is shown by the sum of the weights in the scale pan plus the distortion of the spring *S*. As the contacts *GG* are a very minute distance apart the movement of the lever, and consequently the pen *O* is very slight, and the line traced by *O* is practically a straight one. For the turning moment a torsion dynamometer is inserted in the driving shaft, as indicated in the cut. The propeller

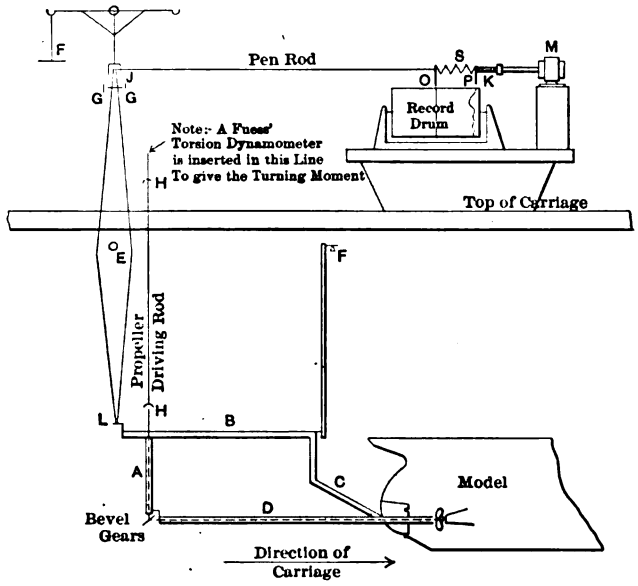

FIG. 20.—DIAGRAM OF APPARATUS FOR RECORDING PROPELLER THRUST, TURNING MOMENT, ETC., AT UEBIGAU.

apparatus, as above described, is arranged so that four shafts can be run at once. This tank also has a wave-measuring apparatus of recent design.

Tank of the French Admiralty at Paris.

This tank, on the banks of the Seine River, in Paris, was opened in July, 1906, and is 523 feet long by 32.8 feet wide by 13.1 feet deep at water level, with a length of tow of about 442 feet. It is the only establishment of its sort in France, though at Brest for the past thirty years model-towing experiments have been carried out in a less satisfactory way, as already described. Paraffine is the model material here as in other European establishments, but Paris has rather high temperatures at times, and it is rumored that paraffine has given some trouble. There is a slight departure from customary practice in the casting of the model, in that an outer carene of wooden lathes, covered inside with canvas and painted, constitutes the mold instead of the tank of clay with the carene hollowed out of it. The core is made and suspended in the usual way, and the rest of the process follows the regular lines. The tank is approximately semi-circular in section, of concrete, and is supplied with water from the city pipes. The carriage is a large steel-trussed structure, weighing 25 tons (French) and driven by four electric motors, one at each corner. It has a speed range up to nearly 1,200 feet per minute, which for a model one-sixteenth size corresponds to about 48 knots. The carriage is about 40 feet long by 35 feet broad, and is equipped with both hull and propeller mechanism, the latter, perhaps, a trifle more complicated than some tanks, as the French government frequently uses triple screws on warships. The staff numbers three electricians, one modeler, one draftsman, and an experimental force of three. The total cost of the establishment was 625,000 francs, or $125,000 (£25,667), and was divided as follows: Tank, 360,000 francs ($72,000) (£14,784); apparatus, 265,000 francs ($53,000) (£10,883).

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The Tank at the University of Michigan, Ann Harbor, Mich.

This tank (Figs 21 and 22), which was finished in 1906, is located in the basement of one of the engineering buildings of the above-named university. It is 300 feet long by 22 feet wide, with a depth of water of 10 feet, and also serves as a reservoir for the adjoining hydraulic laboratories. It has an arched bottom with straight sides, which also serve as the foundation for the engineering building. Along each side is a concrete bracket for carrying the tracks of the towing carriage which spans the tank. At the south end are the docks and the filters through which the tank is filled. The carriage is electrically driven (one motor), and has a speed range of from 15 feet to 800 feet per minute. The resistance mechanism is not radically different from the Froude type, and no propeller apparatus is as yet installed, though it is intended to have one. The models are of paraffine, and range from 10 to 12 feet in length. The summer temperature here is apt to be rather higher than the 75 degrees F. that is customarily believed to be the limit for parafine to satisfactorily retain its form, but it was adopted primarily on account of its cheapness. The tank is in charge of Prof. H. C. Sadler.

There is in addition to the above-named tanks one practically completed at the shipyard of the Mitsubishi Shipbuilding Company, Nagasaki, Japan. The dimensions of this tank are as follows: Length, 430 feet; depth, 12 feet; width, 20 feet. Twelve-foot models of paraffine are used, and the towing carriage is electrically driven. Complete details of this tank have not been made public, but as it is being installed by Kelso & Company, of Glasgow, under the direct supervision of Mr. John Denny, of the firm of William Denny & Brothers, it is safe to assume that it follows the general design of existing British tanks.

In 1904 it was proposed to establish a tank at Bushy, that should be in the nature of a commercial establishment, available to all firms, and it was also to be devoted to the solution of problems of general scientific interest, the results of which were to be freely published. It was criticised in its first aim by those in connection with the existing tanks, on the ground that it would be entirely insufficient, as each owner of any of the present tanks had more than enough work to keep his tank busy all the time. For the second part of the proposition (purely scientific investigation) it was universally considered desirable, but the necessary funds were not forthcoming, and no further steps have been taken.

That the financial gain to a company through increased efficiency by the control of a tank more than returns the interest on the invested capital is evidenced by the fact that no tank has ever been discontinued, and also that several more are projected by private firms. As for the government establishments, the simple statement that tanks are possessed by the six greatest powers is ample proof of the universal belief in William Froude's methods as applied in the modern Experimental Model Basin.

The towing of models by means of a traveling bridge spanning the tank, as in all the foregoing establishments, has several undesirable features for extremely accurate work. First, the speed is never absolutely constant, owing to minute mechanical irregularities of the wheels, tracks and driving motors; second, a large amount of time and power is wasted in bringing the apparatus to speed and in stopping it, as the model is, as a rule, only a small proportion of the total moving weight; third, the high cost of construction and maintenance. There have been several attempts to eliminate or modify these, and recently a scheme, by Mr. H. Wellenkamp, has been attracting considerable attention, especially in Germany, where two tanks are to be built for using his method, one for the Hamburg government and one for the German navy. Briefly,

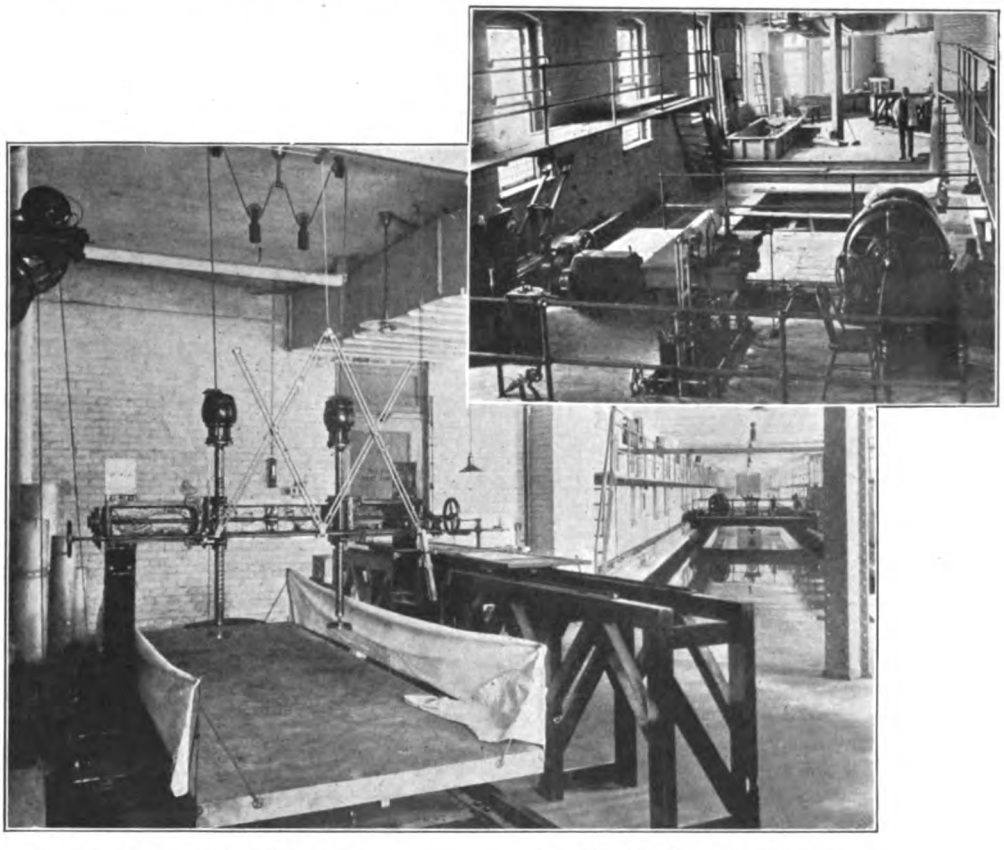

Fig. 21.—Model Cutting Apparatus.

Fig. 22.—The Tank and Carriage.

VIEWS OF THE MODEL TOWING BASIN AT THE UNIVERSITY OF MICHIGAN.

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his method consists in towing models by stationary apparatus on shore and using weights for the towing power, as Beaufoy did, so utilizing the absolutely uniform force of gravity. The acceleration to the desired speed is obtained by a large weight, which is automatically disconnected when the model reaches its speed, and the towing is then continued by a small weight, which continues the towing at uniform speed, and which is the measure of the resistance. The use of the large weight for accelerating quickly to the desired speed permits of the shortening of the tank very materially, and the use of the absolutely uniform force of gravity for the towing force contributes to the same end, as the record, being constant, need be taken only for a very short distance. Mr. Wellenkamp states that the length of the tank should be four and one-half times the length of the longest model to be tested (1½ for the acceleration, 1½ for the run, and 1½ for the stopping), and claims that the cost of construction and maintenance is far less than a basin of Froude's type.

SCOTCH SHIPBUILDING IN 1908.

BY BENJAMIN TAYLOR.

When a year ago we reviewed the shipbuilding of 1907, we said it was not a record year and it did not exceed the preceding year *except in Scotland,* which thus stood foremost in all the shipbuilding centers of the world. But in 1908, even in Scotland, we have but a sorry record. It was a bad year in shipbuilding, as in everything else. Taking once more the statistics of the *Glasgow Herald* (which I know personally to be as accurate as may be) we have the British total of 1,325 vessels of 1,076,562 tons and 1,148,375 indicated horsepower—a decrease from 1907 of 751,733 tons and 627,330 indicated horsepower. The output was divided as follows over the three kingdoms:

	1908.			1907.		
	Ships.	Tons.	I. H. P.	Ships.	Tons.	I. H. P.
Scotland...	680	400,194	528,702	757	675,173	742,289
England...	623	517,752	514,183	1,031	1,014,670	951,176
Ireland....	22	158,616	105,490	38	138,452	82,230
Totals...	1,325	1,076,562	1,148,375	1,826	1,828,295	1,775,705

From the British colonies the returns so far show 167 vessels of 30,451 tons and 11,722 indicated horsepower, as against 189 vessels of 36,344 tons and 14,923 indicated horsepower in 1907; and our foreign returns so far show 1,384 vessels of 1,161,750 tons and 986,062 indicated horsepower in 1908, as against 1,480 vessels, 1,442,958 tons and 1,355,223 indicated horsepower in 1907. This makes a world total in 1908 of 2,876 vessels of 2,268,763 tons and 2,146,159 indicated horsepower, against 3,495 vessels of 3,301,597 tons and 3,145,851 indicated horsepower in 1907; a decrease in round numbers of 1,030,000 tons, which closely approximates the amount of British tonnage now lying idle in the ports waiting for remunerative charters.

Turning attention now specially to Scotland we find a marked contrast with 1907, when there was a large increase in the number of vessels launched, owing to the special demand of the year for small fishery steamers. The number of vessels in 1908, however, was still large in proportion to the total tonnage, by reason of the number of barges constructed and of small vessels for employment in foreign countries taken to pieces and shipped abroad as cargo, this last especially in Scotland.

The total production of the Scotch shipbuilding yards and engineering shops in 1908 consisted of 680 vessels of 400,194 tons and engines of 528,702 indicated horsepower. In 1907 the total was 757 vessels, 675,173 tons, and 742,299 indicated horsepower, so that there has been a reduction of 77 vessels, 274,979 tons and 213,597 indicated horsepower. Most of this tonnage decrease was on the Clyde, but the Forth has fallen from 58 vessels of 21,370 tons and 28,342 indicated horsepower to 25 vessels of 11,143 tons and 14,262 indicated horsepower, and the Dee from 134 vessels of 16,212 tons and 20,035 indicated horsepower to 61 vessels of 7,601 tons and 13,640 indicated horsepower. The Tay alone of the East of Scotland districts shows a small increase. The East of Scotland has not been affected so seriously by bad trade as the West, and Dundee had a fair amount of work all through the year.

The following was the output of the Clyde builders:

	Sail.		Steam.		Total Tons.	1907. Tons.
	Ships.	Tons.	Ships.	Tons.		
Russell & Company	...	....	13	48,619	48,619	71,705
Barclay, Curle & Co.	...	....	6	38,810	38,810	47,332
Charles Connell & Co.	...	....	7	30,698	30,698	40,298
Wm. Denny & Bros.	..	....	15	20,875	20,875	34,418
Alex. Stephens & Sons.	...	....	4	19,904	19,904	44,094
D. & W. Henderson & Co.	2	234	4	17,571	17,805	35,886
The Fairfield Company	...	....	3	17,520	17,520	48,020
Caird & Company	...	....	2	16,723	16,723	6,437
Napier & Miller	...	....	4	16,211	16,211	19,785
John Brown & Co.	...	....	3	15,300	15,300	35,293
Wm. Beardmore & Co.	..	....	1	11,533	11,533	14,500
Wm. Hamilton & Co.	...	....	2	11,386	11,386	41,305
A. MacMillan & Son.	...	....	5	9,715	9,715	21,918
Wm. Simons & Co.	22	1,990	9	5,943	7,933	4,773
Clyde Shipbuilding Co.	...	....	4	7,201	7,201	10,981
A. & J. Inglis	...	....	5	6,777	6,777	3,503
Lobnitz & Co.	3	180	20	6,483	6,663	5,772
Green'k & Grangem'h Co.	...	....	3	6,524	6,524	16,337
Ailsa Shipbuilding Co.	16	1,200	6	4,695	5,985	10,778
Fleming & Ferguson	2	1,200	8	3,850	5,050	6,153
Mechan & Sons.	183	4,085	1	120	4,205	3,011
Scott's Shipbuilding Co.	...	....	2	4,171	4,171	20,916
Ferguson Bros.	...	....	9	3,086	3,086	4,500
Alley & MacLellan	19	2,190	6	740	2,930	2,704
Yarrow & Co.	...	....	13	2,813	2,813	....
Bow, McLachlan & Co.	20	1,800	4	561	2,370	3,217
D. J. Dunlop & Co.	....	....	1	2,308	2,308	2,000
Mackie & Thomson	...	....	17	2,157	2,157	3,663
A. Rodger & Co.	...	....	2	1,801	1,801	22,674
John Fullerton & Co.	...	....	5	1,883	1,883	3,011
Scott & Sons.	...	....	11	1,629	1,629	2,436
Ardrossan S. B. Co.	7	140	7	1,377	1,517	873
George Brown & Co.	..	....	3	978	978	3,186
John Reid & Co.	...	....	2	412	412	71
Ritchie, Graham & Milne.	6	310	3	67	377	1,885
P. Macgregor & Sons.	1	25	7	289	314	481
William Fife & Son	6	297	...	....	297	297
Murdoch & Murray	...	....	1	282	282	6,850
J. & J. Hay.	...	....	1	92	92	70
Other Firms.	31	369	32	273	642	15,786
	318	14,119	251	341,467	355,586	619,919

The production of Clyde shipyards has fallen to the level of 1894. The tonnage increased steadily from 1904, rising each year by about the same amount, until at the end of 1907 the Clyde produced almost 620,000 tons. The anticipations of a decline in work in this district were realized in 1908, very soon after the year began. The labor troubles on the Northeast coat of England diverted a few contracts to the Clyde, but they were not sufficient to rally the industry generally. The Northeast coast and the Clyde are so closely bound together by organizations of employers and of men that the slightest trouble in one place immediately affects the other. When, therefore, the employers and men on the Tyne, Wear and Tees came to loggerheads, builders on the Clyde were chary of fixing dates for the delivery of vessels, and the placing of contracts was deferred until the industrial atmosphere cleared. It did clear up, but the trade situation became worse, and shipowners would only order new vessels at extremely low prices. The work under construction steadily dwindled. At the end of the year the output was 569 vessels of 355,586 tons, as compared with 526 vesels of 619,919 tons in 1907. The number of vessels is larger, but this is accounted for as above. Of ordinary cargo and passenger vessels a much smaller number than usual were launched, and there were less than half a dozen first class passenger liners. Large warships, too, are conspicuous by their absence from the year's list of launches. There were only a few destroyers to place against the battleships of 1907.

With such a large reduction in the shipyards it was inevitable that there should be a decrease in the production of the

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Glasgow marine engineering shops. These depend almost wholly on Clyde yards for their contracts. The year's work represents a total of 474,400 indicated horsepower, as compared with 668,527 in 1907—a reduction of 194,127. There was less demand for machinery generally, and less work for the shops in which engines of standard types are constructed, and there were few large or highly-powered vessels built on the river.

In 1907 the Fairfield Company had the largest output of machinery on the river—112,000 indicated horsepower. In 1908, Denny & Company head the list with 57,100, while David Rowan & Company are second with 43,890.

The following is a summary of the Clyde marine engineering returns:

	1908, I. H. P.	1907, I. H. P.
Denny & Co.	57,109	63,200
David Rowan & Co.	43,890	50,220
John Brown & Co.	41,750	73,000
Yarrow & Co.	32,830	.....
Barclay, Curle & Co.	33,150	40,532
Caird & Co.	23,500	7,700
Alex. Stephens & Sons.	20,660	35,930
The Fairfield Co.	20,460	112,009
William Simons & Co.	18,910	7,345
Dunsmuir & Jackson.	18,000	26,250
D. &.W Henderson & Co.	16,650	30,300
W. V. Lidgerwood.	14,150	16,540
Ross & Duncan.	12,940	10,735
John G. Kincaid & Co.	12,850	22,750
Wm. Beardmore & Co.	10,000	11,000
A. & J. Inglis.	9,800	3,509
Fleming & Ferguson.	9,450	9,100
Bow, McLachlan & Co.	9,310	4,220
Lobnitz & Co.	8,970	9,760
McKie & Baxter.	6,920	9,710
Clyde Shipbuilding Co.	6,880	12,600
Ferguson Bros.	6,750	7,709
Ailsa Shipbuilding Co.	5,620	8,000
Muir & Houston.	5,000	10,470
Hutson & Sons.	4,960	4,650
Scotts' Shipbuilding Co.	4,000	11,700
Rankin & Blackmore.	2,700	29,250
Campbell & Calderwood.	2,580	3,620
Gauldie, Gillespie & Co.	2,450	2,700
A. Rodger & Co.	1,900	13,775
James Ritchie.	1,850	1,500
David J. Dunlop & Co.	1,800	2,000
Aitchison, Blair & Co.	1,700	4,380
Renfrew Bros. & Co.	1,300	2,600
Fishers (Limited).	1,120	1,350
Colin, Houston & Co.	1,060	2,890
Allan, Anderson & Co.	660	1,415
J. & R. Houston.	600	365
White & Hemphill.	450	940
J. & J. Hay.	100	70
Other Firms.	.....	5,700
Totals.	474,400	668,527

The following table shows the output of English shipbuilding districts for 1908 in comparison with 1907:

	1908.		1907.	
	Ships.	Tons.	Ships.	Tons.
Tyne.	115	210,110	148	336,922
Tees & Hartlepool.	38	96,061	83	240,268
Wear.	40	85,351	90	295,432
Royal Dockyards.	5	43,060	3	51,800
N. W. Coast.	95	39,232	117	20,645
Humber.	98	21,714	135	36,659
English Channel.	106	10,237	124	9,499
Thames.	112	9,881	270	15,420
Bristol Channel.	14	2,106	61	8,025
Totals.	628	517,752	1,031	1,014,670

The depression was felt much earlier in the North of England than on the Clyde. On the Tyne, Wear and Tees there were decreases even in 1907, but they were small in comparison with those of 1908. The low tonnage is accounted for partly by bad trade, but also by the labor disputes of the early part of the year. In engineering, the North-Eastern Marine Company's Wallsend shop leads for the river with 44,240 indicated horsepower, a reduction of about 22,000 indicated horsepower as compared with last year. The Wallsend Slipway Company's decrease is more pronounced, but in 1907 they had the turbines for H. M. S. *Superb*, which represented 22,500 indicated horsepower. All over, the engineering of the district is only about half what it was in 1907.

In the last few weeks of 1908 there were slightly better prospects on the Northeast coast. A number of orders were placed, but there was great disappointment on the Tyne that only a very small proportion of the recent Admiralty contracts for British cruisers and destroyers has gone to the district. Builders there depend almost wholly on cargo steamers, and they will not be again busy until there is more work for that type of vessel.

The Belfast shipyards all through 1908 were busy, and they have a total of 16 vessels of 156,831 tons, as compared with 32 vessels of 137,360 tons in 1907. Harland & Wolff launched eight ships of 106,528 tons and 65,840 indicated horsepower, and the outlook there for 1909 is favorable, with orders on hand for the two big White Star liners, and vessels for the Bibby, Royal Mail, Australia United, Leyland and other lines.

There is hope that during 1909 the shipbuilding and marine engineering trades of the Clyde will experience a revival, although there is nothing in the present situation to justify the belief. The slight fluctuations of the freight markets and the scrapping of unemployed cargo vessels, have affected the shipyards very little, and but for the recent placing of warship orders the district would have been no busier than it was at the depth of the depression. There has not been any real improvement outside the yards affected by the naval work. Only one yard on the river—Yarrow's—is fully occupied, and in many cases there is only sufficient work to keep the gates open. There has never been a time when the "tramp"-building firms had so few contracts or when there was such keen competition.

Even in the three yards which have obtained naval contracts short time is the rule. The naval vessels consist of one cruiser of 4,500 tons displacement for each of the Fairfield, Clydebank (Brown) and Dalmuir (Beardmore) yards; three destroyers for Fairfield, three for Clydebank, one for the London & Glasgow Shipbuilding Company, Govan, and one for Denny & Company, Dumbarton.

Besides naval work, the Fairfield Company are completing the Orient liner *Otway*, and are building three steamers, each of about 2,000 tons, for the Zealand Steamship Company—a total of about 16,800 tons. The London & Glasgow Shipbuilding Company have an Orient liner on the stocks ready for launching. Mackie & Thomson have three small steamers, aggregating 1,100 tons, for Colonial owners; Alex. Stephen & Sons, Linthouse, two steamers of 11,670 tons; A. & J. Inglis, Pointhouse, a train-ferry steamer of 1,700 tons for South America; D. & W. Henderson & Company, Partick, a small steamer for Aberdeen, and another for Glasgow; Barclay Curle & Company, a steamer of 3,900 tons for foreign owners; John Reid & Company, one steamer of 150 tons; Ritchie, Graham & Milne, two 20-ton barges, and Charles Connell & Company, two steamers of 7,000 tons. At Scotstoun, Yarrow & Company have their new yard full up with Brazilian destroyers and light craft of various types for foreign countries. At Clydebank, John Brown & Company have a paddle steamer for London owners, and at Renfrew there are two dredgers building in Lobnitz & Company's yard, and one in that of Simons & Company. At Old Kilpatrick, Napier & Miller have several cargo steamers, and at Bowling, Scott & Sons have three steamers of about 500 tons. At Dumbarton, Denny & Company are completing the fastest vessel they have yet built—a 33-knot British destroyer—and they have also a large steamer for the New Zealand Shipping Company, another for P. Henderson & Company's Rangoon service, and two vessels for Irish Channel Railway service—altogether about 20,000 tons. McMillan & Son have a large steamer for an Italian firm, and two for other owners—a total of about 15,000 tons. The prospects in Dumbarton are therefore good. At Paisley, Fleming & Ferguson have four vessels, representing about

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3,200 tons; Bow, McLachlan & Company, two of 800 tons, and John Fullerton & Company orders for several small vessels. But although there is a fair amount of work in Greenock yards, the outlook there is not promising. None of the new Admiralty orders went to that district. The contracts on hand make an aggregate of about 45,000 tons. Caird & Company are completing the P. & O. steamer *Malwa*, and they have the sister ship *Mantua* on their stocks almost ready for launching. Scott's Shipbuilding Company have orders for two first-class steamers, each of 7,500 tons. The Greenock & Grangemouth Shipbuilding Company are building two large oil-tank steamers, each of a carrying capacity of over 6,000 tons, and a steamer, 265 feet in length, for the Eastern trade; and George Brown & Company, a coasting steamer of 200 tons. At Port Glasgow, Murdoch & Murray, and D. J. Dunlop & Company have nothing on hand, but the other firms are fairly well supplied for the next half year. A. Rodger & Company have a steamer of 7,500 tons for Glasgow owners, and a steamer of 5,500 tons for Furness, Withy & Company; the Clyde Shipbuilding Company have three vessels, each about 300 feet in length; Ferguson Bros., a large dredger for Buenos Ayres; Robert Duncan & Company, a steamer of 8,000 tons and one of smaller dimensions; Russell & Company, four passenger and cargo steamers, two river steamers and a number of barges; and William Hamilton & Company, a large floating dock for foreign owners and two other vessels of about 7,000 tons each; the Ailsa Shipbuilding Company are building, at Troon, three steamers of 4,790 tons, and at Ayr one of 425 tons; and the Campbeltown Company, two steamers of about 2,600 tons each. There is no new work at the Ardrossan yard.

The work under construction on the River Clyde is about 307,000 tons, as compared with 315,000 at the end of 1907. Govan, Partick and Scotstoun yards have about 100,700 tons; Clydebank, Dalmuir & Renfrew, 25,000; Dumbarton, Bowling and Old Kilpatrick, 43,500; Paisley, 6,000; Port Glasgow, 77,000; Greenock, 45,000; Firth of Clyde yards, 9,000, and other small yards 800 tons.

At the close of our review a year ago we stated that the reversing turbine had not yet been developed, and that the internal combustion engine might displace not only oil fuel and boilers, but also both turbines and reciprocating engines. The oil-motor has come into practical use on board two vessels of the well-known MacBrayne line, employed in the West Highland trade. The reversing turbine has still to come, but meanwhile we have a compromise. Denny & Company, of Dumbarton, were the first to apply the turbine to the propulsion of merchant steamers, and they were the first to demonstrate the practicability for low-speed vessels of retaining the old engines as an auxiliary to the turbine. The New Zealand steamer *Otaki* has proved more economical of steam than her sister ships. When Harland & Wolff have completed the *Laurentic* for the White Star Line's new Canadian service, the combination system will be tested on a larger scale, but there is already no doubt of its success as a compromise.

Engineers are still waiting for the reversing turbine and the adaptation of the fast-running turbine to the slow-moving propeller. But Mr. Mavor, at Glasgow, and Mr. W. P. Durtnall, at London, have each submitted proposals introducing electric control between the turbine and the propeller. Nothing has yet been done in the way of practical experiment, but if successful it will be a more revolutionary development than the combination of turbines and reciprocating engines, although it will leave untouched the great question of motive power. It will not abolish the steam generator, like the oil or gas engine. MacBrayne's two oil-propelled vessels are running satisfactorily, and the Royal Naval Reserve gunboat Rattler has proved that gas engines may be used for a vessel of large size. There is not sufficient evidence yet to justify still larger ships having machinery of similar types, and at present the most promising line of development is that of electric control between the turbine and the propeller.

The cost of building new merchant steamers is roughly estimated to have declined 10 percent during the year. The actual decline is probably more, as builders are disposed to anticipate a further decline in material, if not in labor. But as second-hand vessels only a few years old have been purchasable at a decrease of 25 percent, and older vessels at a still greater depreciation, there is not much inducement to order new vessels of the ordinary tramp type, especially in the present state of the freight markets.

PROPELLERS.

BY W. G. WINTERBURN.

In a recent issue of this journal I noticed that among the propeller patents our old friend, the continuous paddle, had once again been resurrected. It is astonishing how this idea has struck the minds of so many would-be inventors, who, if they only consulted the archives of the patent offices, would learn that it has been "discovered" over and over again, to say nothing of the numberless inventors who have made no efforts to protect it.

No less a personage than the governor of a British Crown colony, on a trial trip which he honored by his presence, presented me with the suggestion, which he assured me he had thought about a great deal, but his official duties left him no time to experiment and perfect it. He was astonished when I informed him that I had heard of it for years, and that the scheme was impracticable.

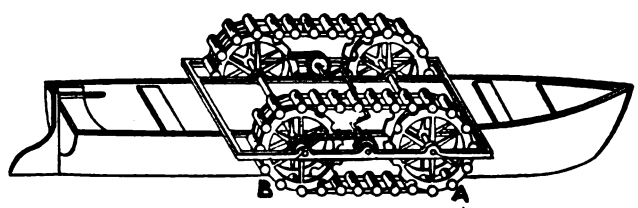

FIG. 1.

The idea is to have an endless chain or belt fitted with numerous paddles and revolving about two drums, one near each end of the vessel; apparently the longer the ship the more paddles will come in operation, and the faster will she travel. Devices for feathering the floats flat when moving forward and other constructive details need not be considered here; it is only the fallacy of the principle that I will endeavor to elucidate.

For the purpose of illustration I borrow Fig. 1 from a back number of this journal. One of the floats enters the water at *A* and emerges at *B*. Assuming, for argument, that slip is non-existent, the boat will travel this distance, which we will make equal to the circumference of the wheel at the center of effort.

As this float emerges at *B*, another one is just entering the water at *A*. It is obviously superfluous to have a train of floats or paddles between these two, although they are so shown on sketch. The one float traveling sternwards is pushing back a body of water equal to its area, but unless those in its wake can travel faster they have no propulsive effect; the floats following at same speed merely add weight and friction.

Allowing for losses due to obliquity of the floats entering and leaving the water, the advancement of the boat per revolution is, in this case, the distance between the centers of the wheels; if we double the distance we would have to give the wheels another turn to push the boat that much further for-

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ward, but it would be no use adding more paddles. In an ordinary feathering wheel, the work done by each paddle—eliminating slip—pushes the boat forward a distance equal to the chord of the arc of immersion *c d* (Fig 2). As the paddle passes the bottom center its useful effort diminishes, but the work is being taken up by the succeeding blade, and so the action is continuous. What advantage would be gained by

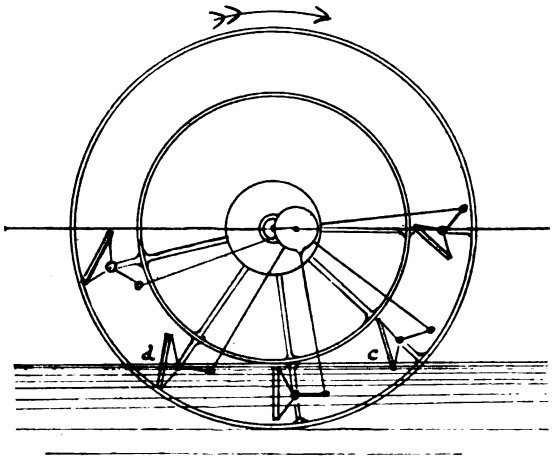

FIG. 2.

causing the blade to follow up the stream sent astern, unless its motion could be accelerated, it is difficult to see.

If an instantaneous photograph be taken of the wheel of a rapidly moving vehicle, the spokes of the upper half appear to be traveling much faster than those of the lower. Take a point P (Fig. 3), in half a revolution it will arrive at P_1, and the vehicle will have moved forward $\frac{3.1416}{2} = 1.5708$; but P will only have traversed in a forward direction that distance, less the diameter of the wheel. From P_1 to its original position at P the point has to travel horizontally 1.5708, plus the diameter of the wheel in the same period of time; hence

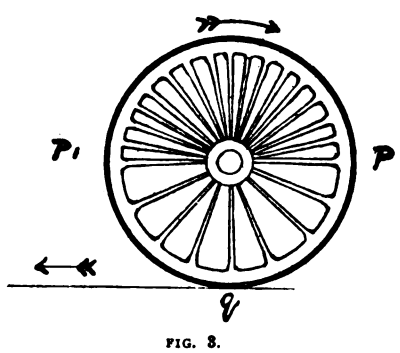

FIG. 3.

the apparent paradox of the top half of a wheel running with twice the velocity of the lower half.

This seemingly impossible feat is accomplished when the point is revolving about a center which is moving, but if the path of the point on arriving at q be continued laterally, as shown by the arrow, another point traveling in the opposite direction covers exactly the same distance in the same time, the acceleration appearing in the upper left-hand quadrant of the rear wheel being but transferred from the front one. It will thus be seen that the only propulsive effect obtained by the belt-paddle system is that due to one wheel, the other and the intervening chain of floats being merely incumbrances.

THE PACIFIC LINER LURLINE.

BY HOLLIS F. BENNETT.

The *Lurline* is a three-masted, schooner-rigged vessel of the spar-deck type, with raised forecastle, poop and 'midship house. Uncommon with large Pacific liners of this class, the ship has her machinery placed in the stern of the vessel under the poop deck, as is common with vessels on the Great Lakes.

She was built by the Newport News Shipbuilding and Dry Dock Company for the Matson Navigation Company, of San Francisco, for use as a passenger and freight steamer, in that company's service between San Francisco and Honolulu and ports on the Hawaiian Islands. The construction of the vessel was carried out to full Lloyds requirements throughout.

HULL DATA.

The general dimensions are as follows:

Length between perpendiculars..	420 feet.
Length over all.....	436 feet.
Beam, molded.....	53 feet.
Depth	33 feet 6 inches.
Draft	26 feet.
Displacement, 26-foot draft.....	10,000 tons.
Trial speed, burning coal.....	14.6 knots.

The hull is of mild steel throughout, built especially strong and rigid. The keel is of the flat-plate type, connected to a wrought-steel stem, 12 by 3⅛ inches, and to the steel stern frame, which is 12 by 7¾ inches. There are five watertight bulkheads, and the frames are spaced 26 inches apart. It is noteworthy that the bulkhead between the engine and boiler rooms is non-watertight. There are five decks, the lowest, the orlop, extending from the stem to the after end of No. 1 hold. The main and spar decks extend the whole length of the ship, and, like the orlop deck, are of steel throughout, the spar deck being sheathed with 3 by 2½ yellow pine in way of forecastle, poop and 'midship house. 'Midships are the upper and bridge decks, both of wood.

The 'tween decks are specially designed for the carriage of package freight, while the holds are fitted for carrying raw sugar in sacks, which constitutes the principal cargo from the Hawaiian Islands.

The main and the orlop decks divide the forepeak into three sections, the lower being used for trimming, the middle section and the orlop deck for the stowage of chains, and the upper section on the main deck for the spare sails, ropes, cargo, gear, etc.

The crew's quarters are forward, under the forecastle head, together with the carpenter shop, boatswain's locker and windlass engine. In the 'midship house, on the spar deck, are located the dining saloon, the pantry, ladies' and men's baths and fourteen staterooms. On the upper deck are the smoking room and the social hall and six staterooms. Two of these rooms are outside rooms, arranged en suite with private bath. The dining saloon is finished in white and gold, as are all the staterooms. The social hall and smoking room are finished in mahogany, with upholstery done in dark brown. On the bridge deck are the wheel house, chart room and the captain's room and officers' quarters.

Aft, under the poop, are the engineers' quarters, together with the quarters for the oilers, water-tenders, firemen, cooks and waiters. The galley, officers' and crew's mess rooms are also located on this deck (spar). The *Lurline* has three steel masts with derrick booms attached, as follows: The foremast, four 8-ton and one 15-ton; mainmast, four 8-ton; mizzenmast, one 5-ton, for handling weights in the engine room. She is equipped with two bower, one stream and one kedge anchors, all stockless. The windlass is of the Hyde Company's make. The foremast and mainmast are each equipped with four of the Murray Iron Works (of San Francisco) single-drum, reversible high-speed cargo winches. For steer-

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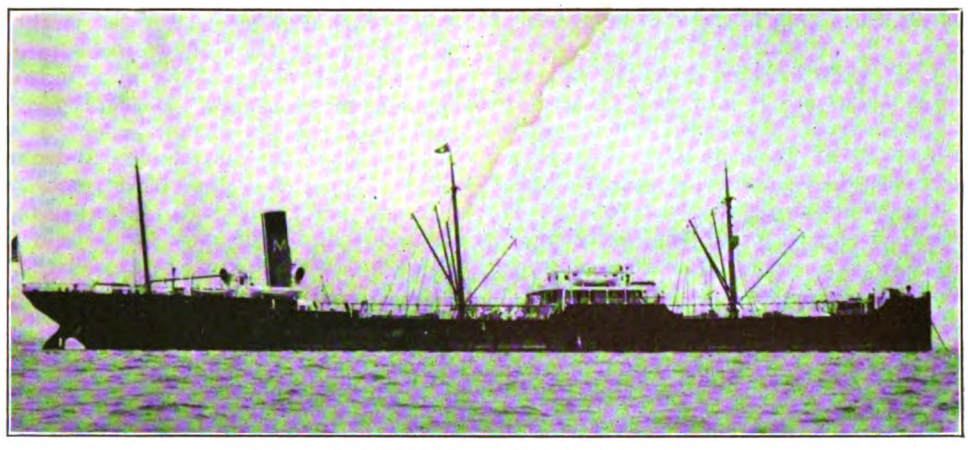
ing, she is fitted with Brown's patent steam tiller and telemotor gear. Four 22-foot metallic lifeboats make up her equipment.

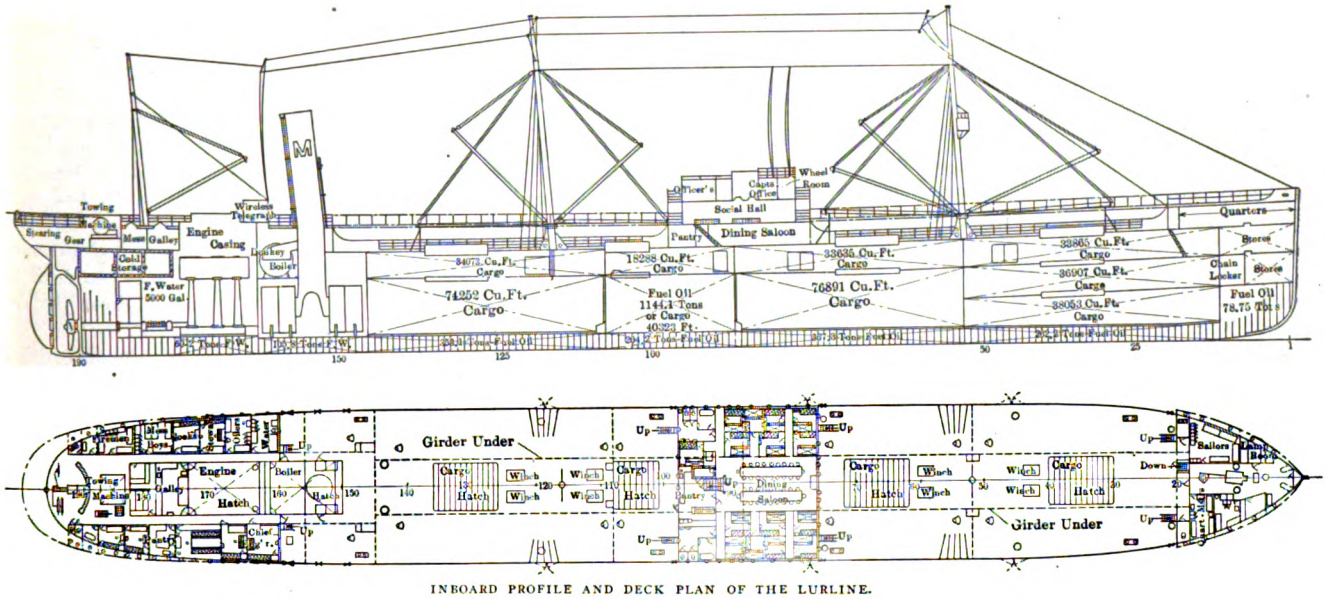
The ship's masts are secured in her in a noteworthy manner. Contrary to usual practice, they do not go through the spar deck, but rest upon it, stayed by extra heavy wire rigging, with the bases secured to the deck by four braces made up of plate and angle bars.



THE LURLINE AT ANCHOR IN SAN FRANCISCO HARBOR.

MACHINERY.

The ship is propelled by one fore-and-aft triple-expansion engine, with cylinders 31, 50 and 84 inches diameter, with a common stroke of 54 inches. The cylinders are arranged with the high-pressure forward, followed by the intermediate and the low-pressure in the order named. The cylinder walls are 1½ inches thick, with no liners fitted. The valves are all forward of their respective cylinders, and are of the 15-inch piston type in the high and intermediate, and of the double-piston slide type on the low-pressure cylinders; there being one on the high-pressure, two on the intermediate and one on the low-pressure cylinder, and all the valves are fitted with balance pistons. Stephenson valve gear is fitted with cast-iron sheaves, cast-steel straps and forged-steel rods and stems. The links are the double-bar type, and with the link block are of wrought steel. The pistons are all of cast iron, fitted, in the high and intermediate-pressure cylinders, with ramsbottom rings. The piston rods are of wrought steel, 7 inches in diameter. The connecting rods are wrought steel, 6⅝ inches and 8 inches in diameter, and 10 feet 2 inches from center to center. The crossheads are wrought steel, with slippers of cast iron, lined with babbet metal. The engine is supported on cast-iron, box form, back and front columns, bolted to a cast-iron bedplate. The crank shaft and pins are 16½ inches diameter, and are joined by wrought steel webs, 87 inches long by 54 inches wide. There is a 14 by 20-inch reversing engine, and an 8 by 6-inch turning engine fitted to the main engine. The main steam pipe is 10 inches diameter. The engine room extends the full width of the ship up to the main deck. On the main deck, on the port side, is the dynamo and ice-machine room, and on the starboard side is the engineers' workshop and tool room. The ship is fitted with a complete cold storage plant on the main deck aft of the engine room casing.



INBOARD PROFILE AND DECK PLAN OF THE LURLINE.

BOILERS.

There are five Scotch return tubular boilers, four main boilers and one donkey boiler. The main boilers are 16 feet 4 inches mean diameter and 11 feet 6 inches long, built to withstand a working pressure of 180 pounds per square inch. Each boiler has four Morison furnaces, 39 inches in diameter

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and 17/32 inch thick, attached to separate combustion chambers. The grate surface for one boiler is 78 square feet; heating surface tubes, 2,222 square feet; heating surface furnaces, 216 square feet; heating surface combustion chambers, 288 square feet; total heating surface for one boiler, 2,726 square feet. The net area of the tubes in one boiler is 13.75 square feet, and the length of grate bars, 6 feet. The ratio of heating surface to grate area is 35 to 1, and of grate area to tube area 5.68 to 1.

The boiler shells are 1 13/32 inches thick, the back and front heads and tube sheets are ¾ inch thick. There are double butt-straps treble riveted, the outside 1 1/16 inches and the inside 1 13/32 inches thick. The main stays are 3⅛ inches diameter, upset at the ends to 3½ inches and spaced 14 inches center to center. There are 254 ordinary tubes, No. 11, B. W. G., 8 feet 1¼ inches long, expanded into both tube sheets, and 106 stay tubes, 5/16 inch thick, screwed into both tube sheets. All tubes are 3 inches inside diameter.

AUXILIARY MACHINERY.

The condenser is independent, with cast-iron shell and ¾-inch brass tubes. The circulating pump of the single-acting centrifugal type with an independent engine, 11 by 11 inches. The suction and discharge pipes are 15 inches in diameter. The other pumps are as follows: Air pump, one Blake twin beam, vertical, 10 by 23½ by 15 inches with 9-inch suction from condenser and 8 and 5-inch discharges to feed tank and bilge. Main feed: Blake special duplex center-packed plunger pump, 12 by 7 by 10 inches. Auxiliary feed: duplicate of main feed. Donkey boiler feed: one Blake center-packed duplex plunger pump, 7½ by 3½ by 6 inches. Fire and bilge: one Blake horizontal duplex, 10 by 7½ by 12 inches. Ballast pump: one Blake special duplex, 12 by 10 by 12 inches. Fresh water pump: Blake duplex, 6 by 4 by 6 inches. Sanitary pump: Blake duplex, 6 by 4 by 6 inches. Fuel oil pumps: two Blake duplex 6 by 4 by 6 inches. Evaporator feed pump: one Blake duplex, 4½ by 2¾ by 4 inches.

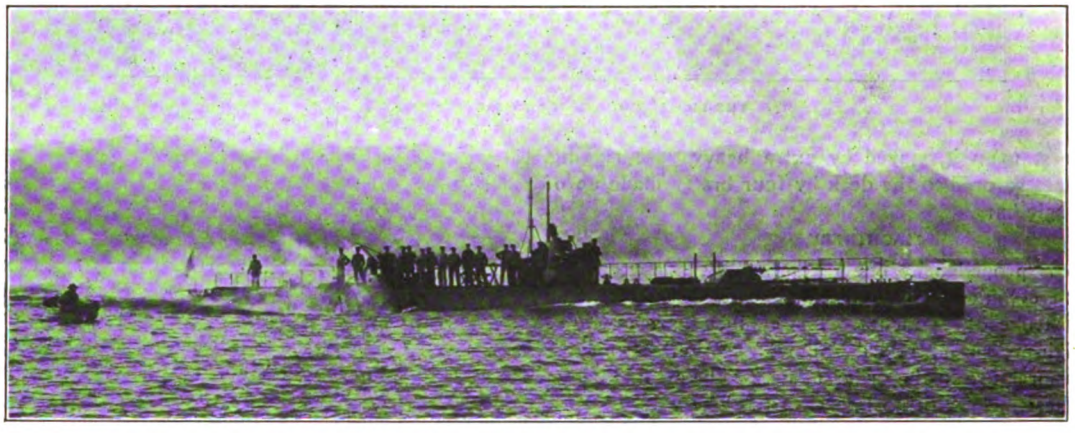

FIG. 1.—THE FOCA AT CRUISING SPEED.

DONKEY BOILER.

The donkey boiler is a two-furnace single-end Scotch boiler, 11 feet 6 inches mean diameter and 10 feet 6 inches long, built for a working pressure of 180 pounds per square inch. There are two Morison furnaces, 44 inches in diameter and 17/32 inch thick, with a common combustion chamber. The grate surface is 44 square feet; heating surface, tubes, 1,170 square feet; furnaces, 114 square feet; combustion chamber, 137 square feet; making a total heating surface of 1,421 square feet. The net area of the tubes is 6.03 square feet, and the length of grate bars 6 feet. The ratio of heating surface to grate area is 32.25 to 1, and of the grate area to tube area 7.3 to 1.

The boiler shell is in two courses, 1 5/32 inches thick, the heads and tube sheets are ¾ inch thick. There are eight main stays, 2⅞ inches diameter, upset at the ends to 3¼ inches diameter, spaced 15 inches center to center. There are 176 ordinary tubes, No. 10 B. W. G., and 66 stay tubes, 5/16 inch thick, 7 feet 6 inches long and 2½ inches inside diameter. The hydraulic pressure is 360 pounds per square inch for all boilers.

There is one four-bladed, right-handed, built-up propeller, with cast-iron hub and manganese bronze blades; diameter, 18 feet; pitch, 20 feet; pitch ratio, 1.11; disc area, 254 square feet; helicoidal area, 115 square feet; projected area, 98 square feet; net area, divided by disc area, equals .453; projected area, divided by developed area, .85; rake, 10 inches; hub, 4 feet 5 inches diameter by 3 feet 1 inch long.

There is also fitted in the after part of the poop a Chase's improved towing machine of extra large size.

After completion the *Lurline* loaded 5,800 tons of New River coal at Newport News for the use of the fleet at San Francisco, and had her 'tween decks filled with 2,300 tons for bunker use. She sailed at 3.30 P. M., March 28, 1908, and the engines ran continuously, with the exception of one hour, when the vessel was stopped to tighten up the high-pressure piston rod packing, until Puerta Arenas was reached on April 26, at 1 P. M. After leaving Puerta Arenas the engines were never stopped until the ship anchored in San Francisco Bay on May 20, after a voyage of fifty-three days. The average day's run was 280 miles. Nearly 3,000 tons of coal was burned during the voyage, part of the cargo being used, with an average daily consumption of 54 tons per day. A good average reading of the engine's performance is as follows:

Steam, 175 pounds; vacuum, 24.5 inches; intermediate receiver, 35 pounds; low-pressure receiver, 4.5 pounds; revolutions per minute, 64; indicated horsepower, about 3,200; speed, 10.6 knots.

Upon arrival at San Francisco the grates were taken from the furnaces and the oil-burning system installed. On her first voyage from San Francisco to Hilo and Honolulu she made the run from port to port, a distance of 2,150 miles, in five days and twenty-one hours, at an average speed of 15 knots. She was loaded at the time with about 1,800 tons of general cargo. On the return trip she was loaded with 9,000 tons of raw sugar, and was seven days eight hours out, with an average speed of 12.4 knots.

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THE ITALIAN SUBMARINE TORPEDO BOAT FOCA.

The Royal Italian submersible torpedo boat *Foca*, built by the Fiat-San Giorgio, Ltd., Spezia, Italy, is constructed with the *Laurenti* type of hull, which has been used in the Italian navy since 1905. The *Squalo, Narvalo, Otaria, Glauco* and *Tricheco* are all examples of this type. The *Laurenti* system of hull construction is radically different from that usually adopted in the construction of submersible boats. From the cross section, shown in Fig. 3, it will be seen that the usual circular shape has been discarded for one which allows better utilization of interior space without the necessity of large displacement. For instance, if, after the preliminary designs for a submersible have been made, it is found that to accommodate the necessary machinery will require an internal breadth of 3½ meters (11.48 feet), with a circular-shaped hull, it would be necessary to have a boat 3½ meters (11.48 feet) in diameter with a consequently large displacement. With the *Laurenti* type of hull the height may be reduced, as in this case, to 2 meters (6.56 feet), which gives ample room for installing the machinery and, at the same time, decreases the displacement of the boat. Not only is the smaller tonnage an advantage for practical maneuvering, but with the smaller boat and same propelling machinery it is possible to realize both a greater surface speed and a greater radius of action.

Circular-sectioned hulls do not give any warning of the amount of stress to which they are subjected while under external pressure, unless the stress exceeds the ultimate strength of the material and collapse occurs. On the other hand, with the *Laurenti* type of hull, since the cross sections are in the form of elastic arches, it is possible to follow their deformations under external pressure and by means of proper calculations obtain exact data regarding the magnitude of the stresses caused by the external pressure.

The principal dimensions of the *Foca* are as follows:

Length over all, 139.35 feet; beam, 16.25 feet; draft, maximum, 8.27 feet. The boat is propelled by three screws, each driven by a group of internal combustion motors of the Fiat type of about 300 horsepower each. The central motor is located in a watertight compartment, which can be shut at the very last moment before diving, and, as there is no need of using the after part of the boat in submerged navigation, it is possible to keep the central motors in operation until the exact spot is reached where it is intended to submerge the boat.

On her official trials the *Foca* maintained a speed of 15 knots for two consecutive hours, with her three motors developing only 820 horsepower. After this trial the motors were run at 600 revolutions per minute, and an eight-hour run was made on which an average speed of 12.2 knots was attained. With the central motor alone operating at 620 revolutions per minute, the cruising speed was found to be 10 knots, and the consumption of fuel only 125.69 pounds per hour. The fuel tanks are capable of carrying 17,140 pounds of fuel, consequently the radius of action at a speed of 10 knots is about 1,400 nautical miles.

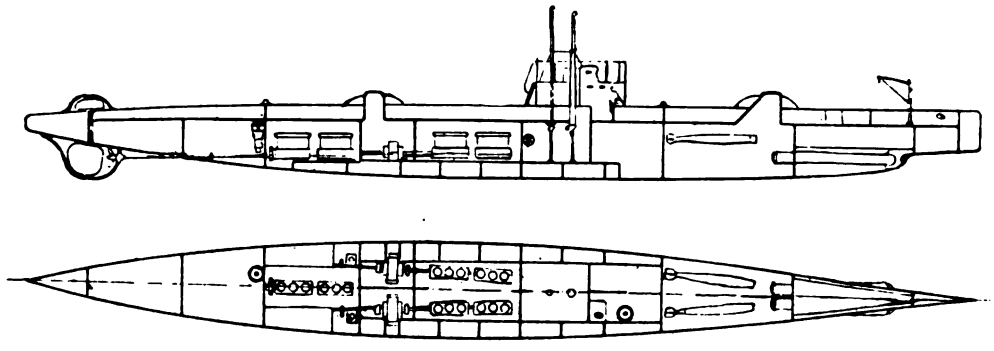

FIG. 2.—GENERAL ARRANGEMENT OF THE FOCA.

The *Foca* was kept submerged for some time in the neighborhood of the Gulf of Spezia, with her keel at a depth of 144 feet below the surface of the water. All deformations of the hull were found to be absolutely elastic, and the boat and fittings in perfect condition after the trial.

The conning tower is located a little forward of amidships, and is built of strong, nickel-steel plates. There are three means of gaining access to the boat, and, consequently, good ventilation can be secured. When submerged the boat is driven by electric motors developing about 110 horsepower each. Her radius of action in this condition is 65 nautical miles at a speed of 6 knots.

Besides the main propelling machinery, the following auxiliaries are installed: Two electrically-driven suction pumps, capable of exhausting 130 tons of water per hour each from a depth of 131.2 feet. These pumps are to be used for exhausting the water ballast in case the compressed air supply is insufficient. There are two air compressors of the Whitehead type, and also two electrically-driven auxiliary pumps.

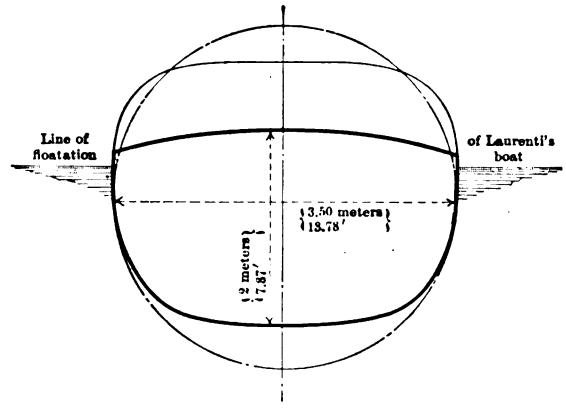

FIG. 3.—THE LAURENTI HULL COMPARED WITH OTHER SHAPES.

The boat is fitted with two torpedo tubes for 18-inch Whitehead torpedoes, and has a capacity for carrying four torpedoes.

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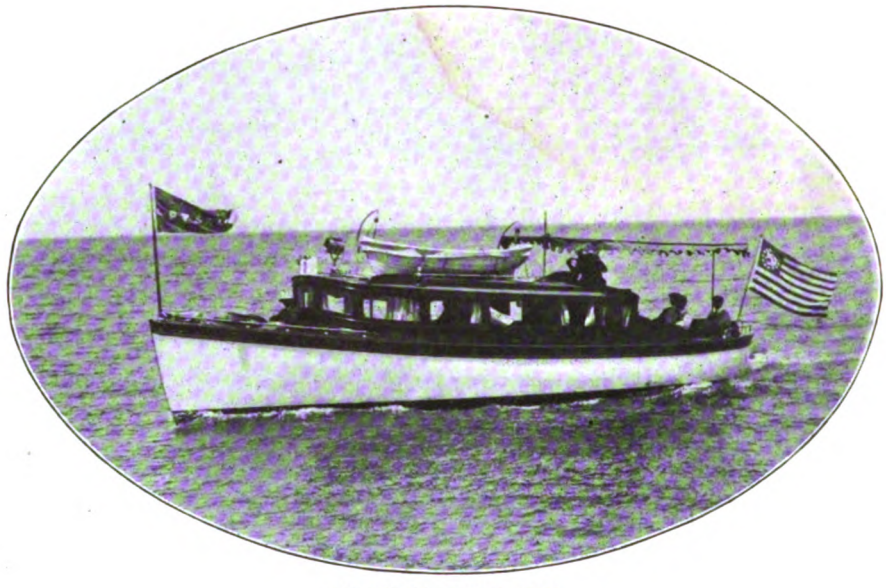
THE MOTOR BOAT MARENGING.

Probably the most interesting American-built motor boat to be placed in commission this season is the *Marenging*, designed and built by the Truscott Boat Manufacturing Company, St. Joseph, Mich., for H. L. Aldrich, publisher of International Marine Engineering. This boat is unique in that she is propelled by a producer gas plant. She has been fitted with this type of power plant solely for experimental purposes, in order to determine the feasibility of using producer gas for marine work, and during the next few months the most complete and exhaustive tests which can be made will be carried out on this plant to determine the advantages and disadvantages of this type of motive power.

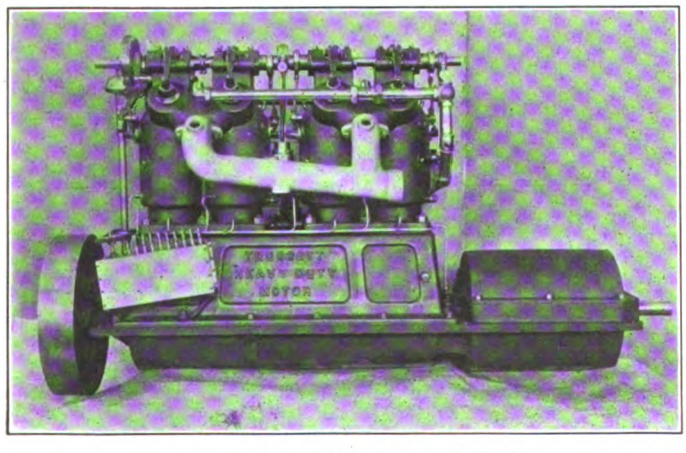


MARENGING AT FULL SPEED.

The principal dimensions of the boat are as follows:

	Feet.	Inches.
Length over all	40	0
Length on waterline	38	6
Beam	9	0
Draft, mean	2	6
Freeboard at lowest point of sheer	2	9
Sheer	0	6

The keel is of good quality white oak, sided 3½ inches, molded 4 inches, cut in long lengths and joined to the stem and deadwood with brass bolts and nuts. The frames are of solid, straight-grained white oak, steam-bent to shape, the smallest being 1½ by 1¾ inches, spaced 9 inches center to center. Oak floors, provided with limber holes, are fitted to every frame. This permits the passage of bilge water without the necessity of cutting the frames. The hull is planked with clear, red cypress, 1⅛ inches thick, smoothed on both sides. All butts are made between frames with oak reinforcements. The sheer strake is of selected white oak, and all fastenings are copper-riveted over large washers upon the inside. A watertight bulkhead extends from the keel half-way to the deck at the bow, just aft of the tank. The wales are put in with as long lengths as possible, and are of yellow pine and white oak, 2 by 3½ inches, securely fastened with bolts. The deck beams are of oak, ⅞ inch thick and 2½ inches deep. The deck is of Honduras mahogany 1 inch thick. The frame work of the cabin, the fenders, strake and moldings are all of white oak.



FOUR-CYLINDER MOTOR OF THE MARENGING.

The forward part of the boat is taken up entirely by the main cabin, the design of which is a compromise between the old-style full glass cabin and the newer type of hunting or turtle-back cabin, combining the advantages of both. The trunk of the cabin, which extends a moderate height above the deck, is composed entirely of heavy plate-glass sashes, which can be dropped down for the purposes of ventilation. As these sashes are absolutely watertight and of extra strength, the boat loses nothing in seaworthiness by this arrangement, whereas the additional comforts of plenty of light and good ventilation are secured. The main cabin, including an extension of 2 feet below the forward deck, to afford two full sleeping lengths, is 13 feet long. Wide seats, suitable for bunks, are built on each side of the cabin, with lockers underneath, accessible by means of lids on the top and hinged doors on the side. Both the interior and exterior of the cabin are finished in Honduras mahogany, the interior being built up of panel work cut from the solid wood.

Aft of the main cabin are the engine room, galley and toilet. The engine room and galley are 9 feet long and the toilet 5 feet long. Full-length wardrobes are built into the forward engine-room bulkhead. Besides the power plant the engine room contains the necessary lockers, etc., for tools, oil cans and accessories. The galley is fitted with a stand for a stove, and the space on top of the stand and behind it is sheathed with copper. Below the stand there are commodious cupboards for stores.

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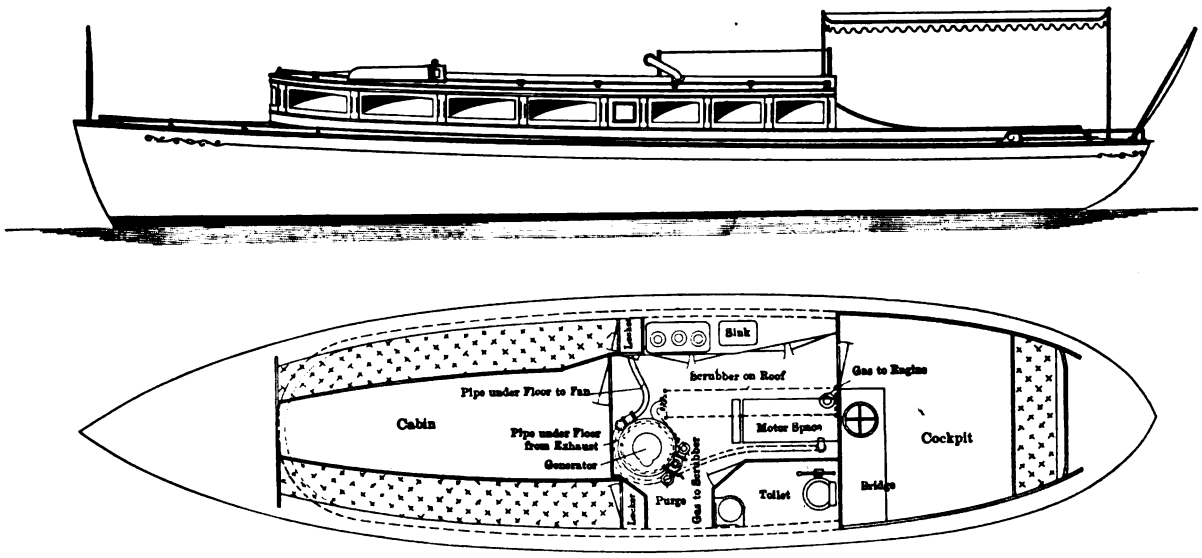
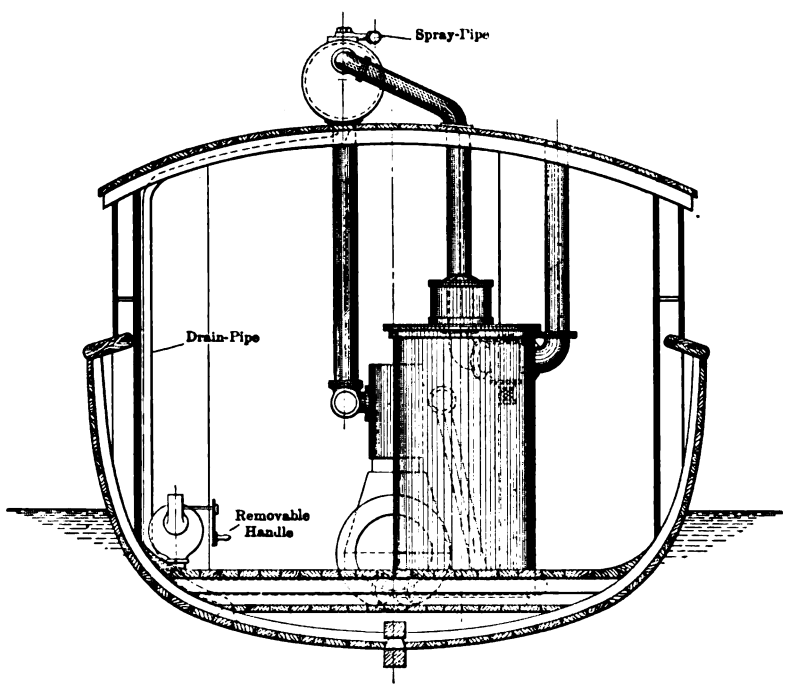


GENERAL ARRANGEMENT OF THE MARENGING.

Aft of the engine room is the cockpit, which, including the bridge, is 8 feet 6 inches long. The floor of the cockpit is raised to a height above the waterline sufficient to permit self-bailing. It is slightly crowned and pitched to drain through scupper holes in the forward corners. The floor is supported by stanchions to make it thoroughly rigid and solid. A cushioned locker extends across the rear of the cockpit, while the bridge is located just aft of the cabin. Contrary to the usual practice in a boat of this length, the cabin may be entered not only through a door in the rear of the engine room, but also through a watertight hatch in the forward deck.

The top of the cabin is sufficiently strong to support any reasonable weight. It is made of matched white pine, covered with a double layer of heavy paraffin parchment, upon which 12-ounce double-filled duck is tightly stretched and treated with three coats of paint. The carlins which support the roof are of Honduras mahogany, to match the interior finish.

Power is furnished by a 35-horsepower producer gas plant, consisting of a single-suction gas generator and a Truscott heavy-duty, 4-cylinder, 4-cycle engine, having cylinders 5¼-inch bore by 6-inch stroke. The engine is fitted with a reversing gear mounted in an extension of the main bed. The cylinders are bored and reamed to size, and are fitted with long cast-iron pistons. The crank shaft is of drop-forged steel, and the bearings are of genuine Babbitt metal of very large size. Lubrication is effected by a force-feed mechanical oiler attached to the front of the engine and driven from the cam shaft. The oil ducts lead, respectively, to the pistons and crank case of each cylinder and to the forward and after bearings. All of the moving bearings are provided with snap oilers. The inlet and exhaust valves are both mechanically operated, and are located in the cylinder head in removable cages. The cam shaft is located above the cylinders on the longitudinal center line of the engine. The cams are forged integrally with the shaft, and have large ground surfaces for contact with the valve lift-arm rollers. Ignition is of the



ARRANGEMENT OF THE GAS PRODUCER, ENGINE AND AUXILIARIES.

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low-tension make-and-break type, mechanically operated from the cam shaft. The exhaust pipe of the engine is water cooled, extending beneath the cockpit floor, and is submerged beneath the stern of the boat. The reversing clutch is of the improved gear type, fitted with large surface in both gear and pinions, and it is self-oiling.

The bronze propeller wheel is of the three-bladed pattern with solid flukes. The propeller shaft, stern bearing, stern tube and stuffing-box are all of bronze. The stuffing-box is on the inside of the boat, and can be reached through a hatch in the cockpit floor. The bronze shoe, or skeg, for supporting the rudder, is fastened to the keel with long brass lag screws.

The engine is completely fitted with all of the necessary wrenches for access or repair to any part; lubricators, oil cans, etc., together with a complete set of spare valve gear, bolts, nuts, cotter pins, washers, etc.

The gas for the operation of the engine is generated in a single-generator suction gas producer, built by the Marine Producer Gas Power Company, 2 Rector street, New York. The producer is 24 inches in diameter and 4 feet high. The shell is made of tank steel, and is lined with a special grade of firebrick lining, at the bottom of which is attached a shaking grate, available through a cleaning and ash-pit door for the inspection of the fire and the removal of ashes. The fuel is charged into the producer through an automatic vestibuled charging hopper, so arranged as to preclude the possibility of admission of air to the upper zone of the producer. The hot gas is taken off at the top of the producer through a special three-way valve having one common connection with the producer, arranged on one side with a purge stack, and on the other side with a connection leading to the Monel metal gas scrubber, which is located on the deck house over the engine room. This scrubber is 12 inches in diameter and 6 feet long, weighing 60 pounds. In the scrubber the gas is passed through numerous sprays of water, which cool it and cleanse it of all dirt and soot, and prepare it for its proper use in the engine. The gas leaves the scrubber at the after end through a lower connection, and passes directly to a gas and air-mixing valve which is substituted for the ordinary carburetor. This valve is arranged for the proper control of the mixture of gas and air, and also acts as a throttle in order to give the desired speed to the engine.

The operation of the plant is, briefly, as follows: A fire is kindled on the grate, and coal is charged into the top of the producer until the fire is of a proper depth for correct gas making. When hurried starting is desired, a fan, which is located in the locker on the starboard side of the boat, is operated by hand. The air leaving this fan enters the producer underneath the grate, passes up through the fire, and the products escape through the purge pipe until the fuel is heated to the proper gas-making temperature, when the purge valve is closed and communication made with the gas scrubber. A small vent pipe near the engine is then opened to the atmosphere, and the fan turned until gas appears at this vent. This fan is only used in starting the producer, and as soon as the engine is under way the operation of the fan ceases.

The proper adjustment of gas and air is then made at the gas-mixing valve, the spark retarded as usual, and the engine turned over by a special crank furnished for this purpose. By this operation gas and air in the proper proportions are drawn into the cylinders and there compressed, and at the end of the compression stroke the mixture is ignited. The engine immediately comes up to speed, and can be operated with the clutch in a neutral position, or ahead or astern, as desired. The suction stroke of the engine creates a vacuum in the gas main, which communicates with the producer, and serves to draw the proper proportion of air and ingredients through the fire of the producer to make the gas.

The fuel commonly used is anthracite coal of pea or buckwheat size, although either charcoal or coke may also be used. During operating periods the fuel is charged into the gas producer, and the grate is agitated in order to shake down the ash at intervals of from one to two hours. After the boat is docked, or has been moored, and the engine is shut down, the purge valve is put into communication with the purge pipe, and the grate is again shaken, and the ashes, after being wet down, are removed from the ash-pit. The producer is then replenished with fuel, and the fire left in a stand-by condition for an indefinite period. After a twenty-four-hour shutdown, only ten or fifteen minutes blasting with the fan is necessary to bring the fire up to the proper gas-making temperature, when the customary cycle for starting can be carried out.

The gas generated is uniform in character, and has such consituents that preignitions are practically done away with. The temperatures obtained in the cylinders are not nearly so high as with gasoline, and the engine can be operated much easier than with gasoline. Variations in temperature and humidity do not affect the operation so much as with the latter fuel, but for successful operation on producer gas the engine must be fitted with large inlet and exhaust valves and pipes. The Truscott motor used in this installation required no changes in this respect, inasmuch as the valves and piping supplied for gasoline are unusually generous in size, the only changes being in the nature of considerably higher compression than ordinarily met with on gasoline operation, the compression in this instance being 150 pounds per square inch above atmospheric pressure. The initial maximum pressures are about 300 pounds per square inch immediately after ignition, and the mean effective pressure for the working stroke on the piston is about 70 pounds per square inch.

About 1¼ pounds of anthracite pea coal of good quality are consumed per horsepower per hour. The total weight of coal carried, therefore, but slightly exceeds the weight of gasoline which would be ordinarily carried for such a plant operating on this fuel. The engine, complete with clutch, shaft, propeller and fittings, weighs 1,650 pounds. The gas-generating plant, complete with producer, scrubber, fan, purge valve, pipe, fire tools and fittings, weighs 1,000 pounds, a total of 2,650 pounds, or 76 pounds per horsepower.

The control of the plant is so arranged that both the boat and the motor can be handled by one operator on the bridge in the cockpit. Steel rods and levers passing beneath the floor are actuated by tooth and sprocket levers from an automobile type of starting wheel on the bridge. The steering wheel has a brass hub and stanchions, and is fitted with a wooden rim, finished to match the rest of the woodwork. An additional wheel, placed directly below the steering wheel, actuates the reversing clutch, and connections mounted on the bulkhead control both the spark and throttle. An improved type of lock switch is arranged for easy access for starting and stopping the motor. The control levers on the engine are so arranged that they can be operated by the engineer if desired.

The producer plant and engine are finished in black enamel with trimmings of polished brass, the whole outfit lending itself nicely to the handsome finish of the boat.

The annual meeting of the Institution of Naval Architects will be held March 31, April 1 and 2, in the hall of the Society of Arts, John street, Adelphi, London, W. C. The Right Honorable Earl Cawdor, president of the Institution, will preside over the meetings. The programme includes the usual varied subjects of interest covering both naval architecture and marine engineering, and the convention promises to be one of much interest.

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THE ITALIAN BATTLESHIP ROMA.

BY DAGNINO ATTILIO.

The dock trials of the last of the 12,500-ton Italian battleships of the *Vittorio Emanuele* class have recently been completed. This ship is the *Roma*, which was launched April 21, 1907. The other battleships of the class, which are already in commission, are the *Vittorio Emanuele*, *Napoli* and *Regina Elena*. The principal dimensions of the *Roma* are as follows:

Length over all	474 feet 6 inches.
Length between perpendiculars	435 feet.
Beam, extreme	73 feet 6 inches.
Draft, mean, trial	25 feet 9 inches.
Displacement, trial	12,625 tons.
Launching weight	6,000 tons.
Coal supply, normal	1,000 tons.
Coal supply, maximum	2,000 tons.
Steaming radius at 10 knots	10,000 miles.
Estimated speed on trial	21½ knots.

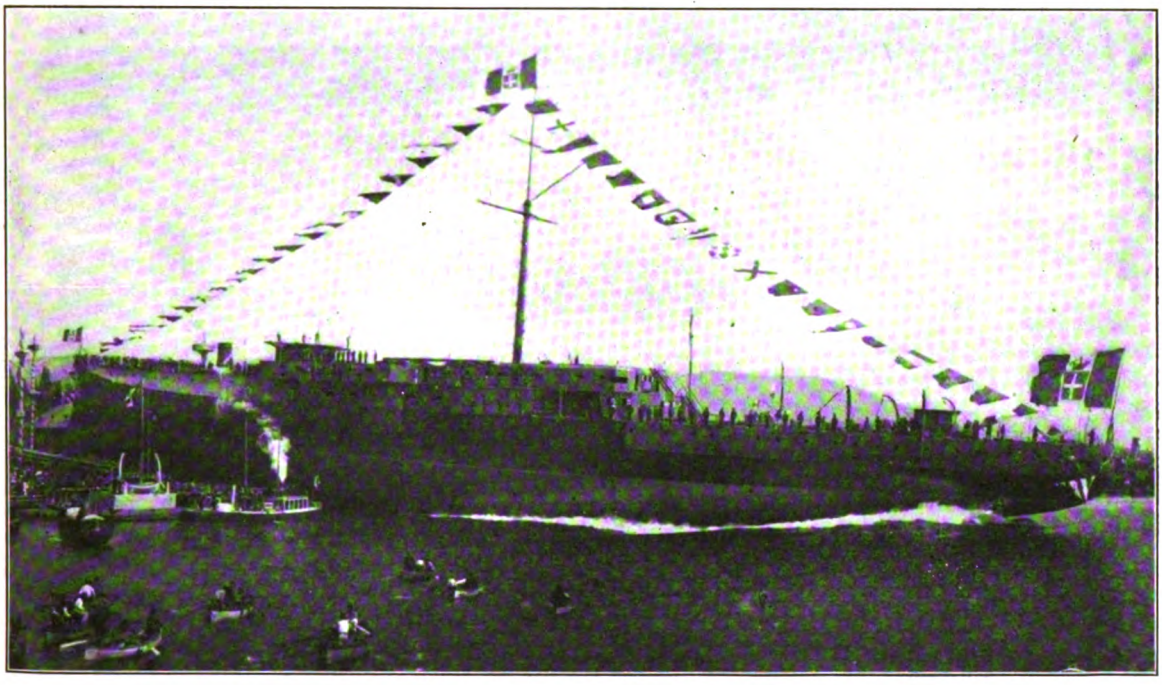
The hull is of steel throughout, and the stem and stern posts and propeller brackets are of cast steel. The armor, which is face-hardened, is distributed as follows: A 10-inch waterline belt extending the length of the machinery space, tapering to 4 inches at the ends; a central redoubt of 8-inch armor and a 3⅛-inch protective deck, worked in forward. The large turrets have 10-inch armor and the smaller turrets 6-inch armor.

The armament consists of two Armstrong 12-inch, 40-caliber, 51-ton guns, mounted on the centerline of the ship, one forward and one aft. Each gun has an arc of fire of 300 degrees, and fires a charge of powder weighing 450 pounds and a projectile weighing 850 pounds, capable of perforating 13 inches of Krupp armor at a distance of 2,000 yards. The rest of the main battery consists of twelve 8-inch Armstrong 45-caliber, 19½-ton guns, mounted in pairs in turrets amidships. These guns fire a projectile weighing 230 pounds, and are capable of perforating 7 inches of Krupp armor at a distance of 8,860 feet.

The secondary battery consists of eight 3⅛-inch, 40-caliber guns; four mounted in barbettes, two at the bow and two at the stern, the remaining four being distributed in commanding positions at the sides. There are also twelve 1⅞-inch rapid-fire guns, four canister guns and two 3-inch landing pieces. The total weight of the bow or stern fire is 2,554 pounds, while the total weight of the broadside fire per minute is 3,042 pounds.

It is noteworthy that the 6-inch guns usually employed for the secondary battery on Italian battleships are absent in the *Roma*. It is claimed by Mr. Cuniberti that, since the 6-inch guns can penetrate only 3 inches of modern armor at a range of 3,000 yards, this gun is ineffective against highly-armored vessels at probable battle ranges, while for the chief work for which they would be used—that is, driving off torpedo boats and small craft—the 3-inch guns are almost equally effective.

The *Roma* is propelled by two sets of triple-expansion engines, designed to develop 20,000 indicated horsepower, giving the ship a speed of 21.5 knots. Steam is supplied by fourteen Babcock & Wilcox watertube boilers. With a bunker capacity of 2,000 tons of coal the estimated steaming radius at cruising speed is 10,000 miles. Electricity is used throughout the vessel for lighting, steerage, hoisting ammunition and operating the turrets.



LAUNCH OF THE ROMA AT SPEZIA, ITALY.

A New Transatlantic Record.

On Feb. 11 the Cunard steamship *Mauretania* arrived off Sandy Hook, having made the run from Daunts Rock, Queenstown, 2,890 miles, in 4 days 17 hours 50 minutes. This is 1 hour 46 minutes less than the best previous record made by the *Lusitania*. On the second day out the *Mauretania* logged 671 miles, making an average speed of 26.84 knots. The average hourly speed for the entire voyage was 25.55 knots. This record, made as it was during the winter months, when the weather conditions were not all that could be desired, seems to indicate that during the coming summer this ship will be able to average a much higher speed than was possible last year. The changes made in her wing propellers have greatly reduced the vibration of the hull, besides adding to the speed.

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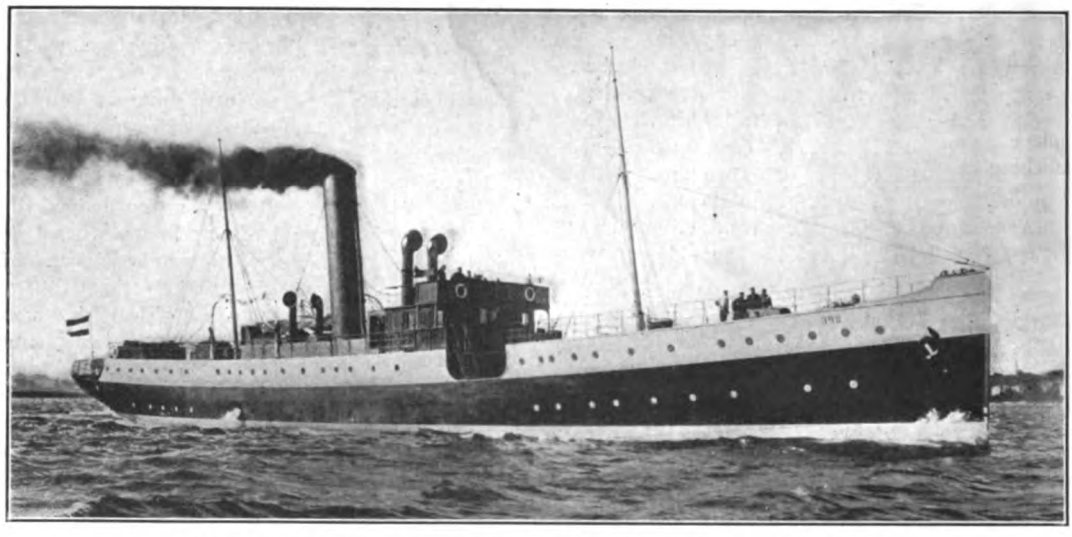
Swiss Steam Turbines for Ship Propulsion and Lighting

BY FRANK C. PERKINS.

It is unnecessary, at this time, to go fully into the question of steam turbines for ship propulsion or for electric lighting on shipboard; but it may be of interest to consider the design and construction of a Swiss steam turbine as applied to marine service, for driving a modern steamer, as well as for operating the electric light and power plant required on such a vessel. The steam turbine is best applied to steamship propulsion when propeller wheels are used and the boats are operated at high speed almost continuously; while for side-wheel river and lake steamers, as indicated by the *Blümlisalp* and *Rhein*,* the reciprocating engine has been used exclusively up to the present time.

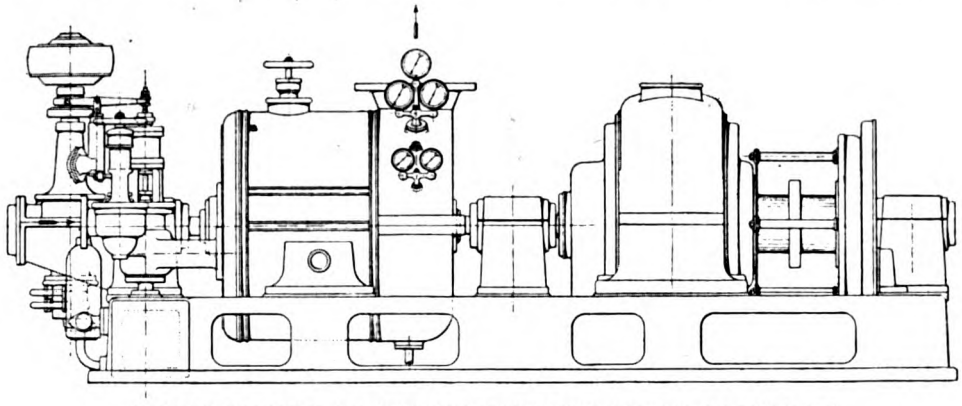


A GERMAN-BUILT STEAMER EQUIPPED WITH ZOELLY STEAM TURBINES FOR PROPULSION.

One illustration shows the Zoelly steam turbine in the shops of the hydraulic turbine builders, Escher, Wyss & Co., Zurich, Switzerland, as completed and ready for installation in the mail steamer *D. S. S. 392*, shown in another illustration, and built at the Howaldt shipyard, at Kiel, Germany. The total capacity of this turbine is 1,000 horsepower, and it is held that on account of the strong construction of the blades and wheels, and the absence of clearances, in the Zoelly steam turbine, it promises to do better than reaction turbines in the realization of a rational marine turbine.

The drawing shows one of the Zoelly steam turbines directly coupled to a direct-current generator for lighting aboardship. It is held that for economy, regulation and reliable service, the steam turbine-driven ship lighting set is ideal. These plants are fitted on the steamers *Blümlisalp* and *Rhein*, and equipped with engines and boilers by Escher, Wyss & Co. The lighting plant consists of a 10-horsepower compound wound direct-current dynamo supplying current at 110 volts pressure for lighting and power service, directly coupled to a steam turbine. This set operates 90 incandescent lamps on each steamer, as well as two arc lights, and is located just forward of the inclined reciprocating propelling engines, as shown in the lower plan on page 443, November, 1907.

In order to operate reciprocating engines at their highest economy, and also to get the best results from steam turbines, either for propulsion or for electric lighting service, the steam supplied must be superheated to a considerable degree. The steam turbine can be supplied with superheated steam at much higher temperatures than reciprocating engines, as with the latter difficulties arise in the matter of lubrication, which are not encountered with the former. In the present case the two boilers are of the Schmidt-Escher-Wyss design, fitted with superheaters, and operated at a pressure of 147 pounds per square inch. The direct heating surface measures 1,280 square feet; the superheating surface, 305 square feet; and the grate area, 31 square feet. Each boiler has a steam space of 88 cubic feet, 154 heating tubes 3 inches in diameter, and sixty superheating tubes 1.1 inches in outside diameter. The superheating tubes are placed within a flue contained in the boiler, and forming, in itself, a part of the water-heating surface. There are two Morison suspension furnaces, 31½ inches in diameter.



ZOELLY STEAM TURBINE AND DIRECT-CURRENT GENERATOR FOR LIGHTING ABOARD SHIP.

* *International Marine Engineering*, November, 1907, page 442.

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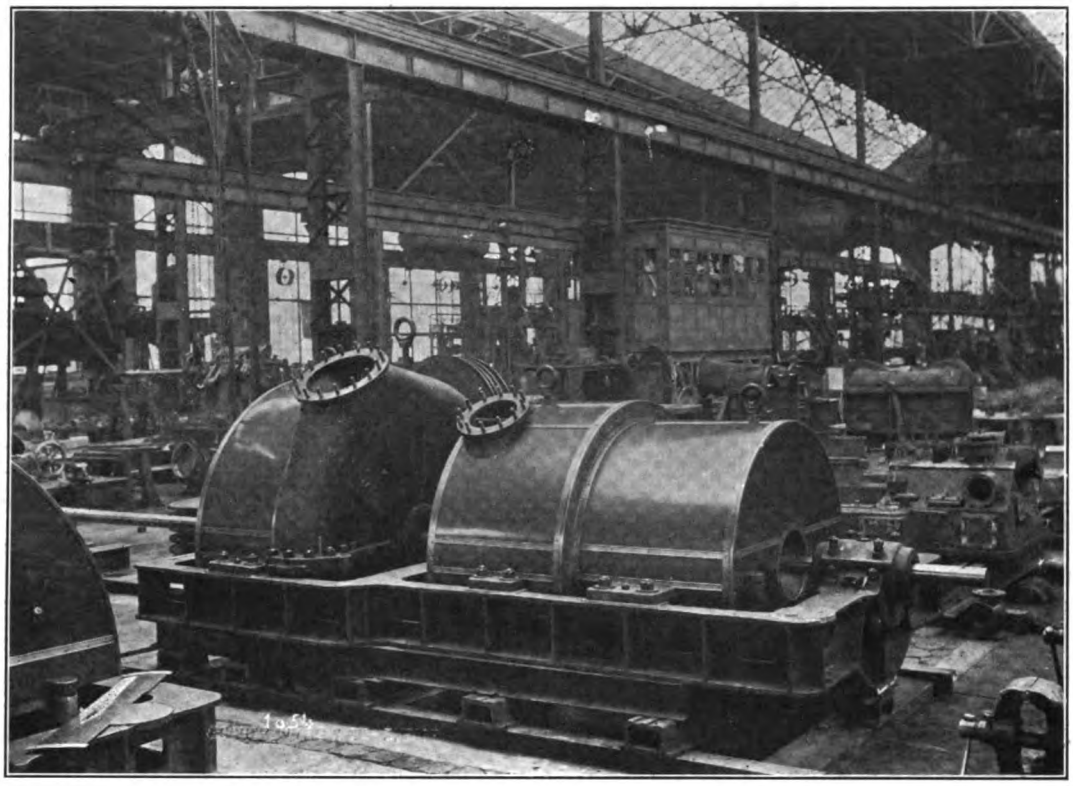


ZOELLY MARINE STEAM TURBINE OF 1,000 HORSEPOWER IN THE SHOPS OF THE BUILDERS AT ZURICH.

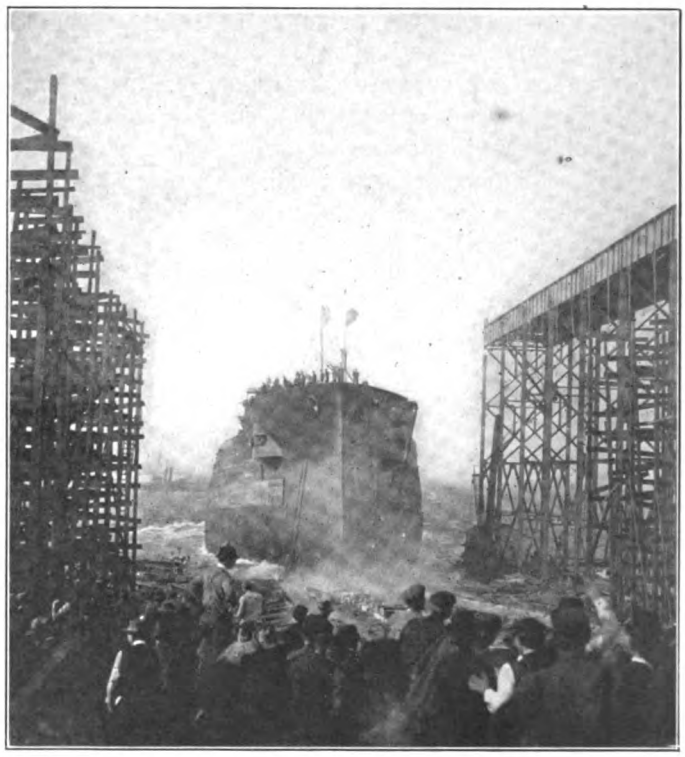
THE LAUNCH OF THE DELAWARE.

The second American *Dreadnought* was launched from the yards of the Newport News Shipbuilding & Dry Dock Company on Feb. 6. She was christened the *Delaware* by Miss Anne Pennewill Cahall, of Bridgeville, Del. The *Delaware* is a sister ship of the *North Dakota*, launched on Nov. 10, 1908, in the yards of the Fore River Shipbuilding Company, Quincy, Mass. Each vessel has a displacement of 20,000 tons, and is designed for a speed of 21 knots. In the *Delaware* propulsion will be by means of two four-cylinder, triple-expansion, direct-acting, reciprocating engines, designed for an indicated horsepower of 25,000, while in the *North Dakota*, Curtis turbines of the same total horsepower are being installed. Babcock & Wilcox watertube boilers are used in both vessels.

The *Delaware* is 519 feet long over all, with a beam of 85 feet 2⅝ inches and a draft at a displacement of 20,000 tons of 26 feet 10 inches. Her armament consists of ten 12-inch breech-loading rifles, mounted in pairs in revolving turrets on the centerline of the ship, in such a manner that all of the 12-inch guns can be fired on either broadside, four of them ahead and four of them astern. The secondary battery comprises fourteen 5-inch rapid-firing guns for repelling torpedo-boat attack. These guns are mounted partly amidships and partly at the bow and stern on the gun deck. There are also four 3-pounder rapid-firing guns, four 1-pounder semi-automatic guns, two 3-inch field pieces, two machine guns of .30 caliber, and two 21-inch submerged torpedo tubes.

The ship is heavily armored, a waterline belt 8 feet wide extending the entire length of the ship. This belt is 11 inches thick amidships, tapering to 4 inches bow and stern. It extends 6 feet 9 inches below the full-load waterline. The side armor is 10 inches thick, which is reduced to 5 inches at the main deck. The 12-inch turrets are protected by 12-inch and 8-inch armor.

The contract for the *Delaware* was awarded to the Newport News Shipbuilding & Dry Dock Company on Aug. 6, 1907, and the keel was laid Nov. 11, 1907. The contract price for the hull and machinery was $3,987,000 (£820,000).



LAUNCH OF THE U. S. BATTLESHIP DELAWARE.

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A Successful Cruise.

For years large fleets of merchant vessels have been steaming regularly month after month back and forth on long ocean voyages, arriving and departing on schedule time, and encountering every condition of wind and sea without serious mishaps or accidents to the propelling machinery or auxiliary apparatus. This reliability has been accepted without comment; but when it was proposed to send a fleet of sixteen American battleships on a year's cruise, first to the Pacific Ocean and finally completely around the world, doubts were freely expressed of the ability of the warships to successfully withstand such a test. The successful completion of this cruise is a splendid refutation of the many criticisms which have been made regarding the quality and reliability of naval machinery. The ships have been at sea fourteen months, and during that time have covered a distance of 42,000 miles without a serious mishap or accident of any kind. Furthermore, at the end of the cruise four of the largest and most recently built ships are able to report no repairs necessary. Such a record as this is greatly to the credit of the designers and builders of the vessels and the men who have had charge of the operation of the machinery en route. Not only have all the officers and men greatly improved in efficiency, as evidenced by the high records achieved at target practice and in the carrying out of battle maneuvers and in the successful navigation of the ships through difficult places under all conditions of weather, but also the records from the stokeholds and engine rooms show that much has been accomplished in the way of increased economy in coal consumption.

Undoubtedly the greatest defect brought out by the cruise is the lack of colliers. A sufficient number of vessels of this type capable of maintaining the requisite speed is absolutely essential to ensure the mobility of the fleet in time of war.

The Motor-Boat Show.

The fifth annual national motor boat show was held at Madison Square Garden, New York City, from February 15 to the 23d, under the auspices of the National Association of Engine and Boat Manufacturers. The display this year, both in size and excellence, greatly surpassed all similar exhibitions which have previously been held, and bore ample testimony to the size and importance which this branch of marine engineering has assumed. Interest in the exhibition was manifested not only by sportsmen and yachtsmen, but also by that rapidly growing class of men who find use for small power craft in commercial pursuits. In the early days of motor boating the question of the complete design for a boat was not as carefully considered as it is to-day, and the results, both as to appearance and performance of the boat, frequently left much to be desired. The present-day motor boat, however, particularly if it is of large size or built for speed, is the result of careful designs by a competent naval architect, who designs not only the shape of the hull and the interior arrangement, but also designs the power plant for the boat. The result of this has been not only the gradual sifting out of the hundreds of nondescript designs and the substitution of recognized types, but also the development of different types of engines especially suited for different purposes. This change is doing much to insure the reliability and success of motor boats, and as soon as the benefits of a harmoniously designed boat are more fully recognized much greater progress can be looked for.

A Gas-Propelled Motor Boat.

This month we are able to publish in detail a description of the 40-foot gas-propelled motor boat which has just been brought out by the publisher of this journal for experimental purposes. Ever since the first attempts were made to use producer gas for the propulsion of ships widespread interest has been aroused in this form of motive power; but as this has taken the form of speculation rather than of investigation, only meager data covering the performance of such installations has been available. It is with a view of obtaining such data that the *Marenging* has been built,

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and as soon as practicable an exhaustive series of tests will be made on the boat to determine the reliability and economy of a modern marine producer-gas plant. The results of these tests will be published from time to time during the coming months, so that our readers will have an opportunity to judge as fairly as may be from the performance of such a small plant the feasibility of using producer gas for marine work. These tests, together with those which will be made on the auxiliary yacht *Carnegie,* which is to be equipped with a 150-horsepower gas-producer plant, will at least furnish a chance for comparison with other fuels, which will be of value both to manufacturers and shipowners.

One result which might be looked for if these early installations prove successful in every way is the development of auxiliary sailing vessels as cargo carriers to compete with tramp steamers. Vessels of the large schooner type are the most economical cargo carriers afloat; but at present they lack means of assuring definite time of arrival at a port of destination, and, due to their inability to overcome the handicap of adverse weather conditions, are able to show an average speed of not much more than four or five knots, as against eight or nine knots for the tramp steamer. The remarkable records for fast sailing which have been made by cargo schooners under favorable conditions lead us to believe that, if some economical form of auxiliary power, such as a producer gas plant, could be installed, the average speed of such ships could easily be brought up to a point which would enable them to successfully compete with tramp steamers.

Revision of the United States Laws Relating to the Safety of Life at Sea.

Last May President Roosevelt appointed a commission, consisting of Capt. Adolph Marix, chairman of the Lighthouse Board; Charles Earl, solicitor of the Department of Commerce and Labor; Eugene T. Chamberlain, Commissioner of Navigation; George Uhler, Supervising Inspector-General of the Steamboat Inspection Service, and Commander William Strother Smith, of the United States Navy, to make a careful investigation of the laws of the United States enacted for the better security of life at sea, with a view to their better adaptation to present needs. After careful inquiry, this commission has made its report in the form of a bill into which are incorporated the present laws, carefully revised as seemed necessary to the commission, and such new matter as seemed desirable in view of present needs. The bill is very long and is divided into six articles, dealing respectively with the marine-inspection service, the inspection of vessels and machinery, life-saving and fire-fighting equipment, the officers and crew, transportation of passengers and merchandise and the enforcement of the act. The provisions of this bill deserve careful consideration by every one whose interests are affected in any way by it, for some of its recommendations seem unnecessarily severe, such, for instance, as that requiring every motor boat, under penalty of $1,000, to have at least one substantial life-boat aboard. In an endeavor to make the inspection service as efficient as possible, the commission has recommended increasing the salaries of the supervising inspectors and local inspectors in order to assure the best class of men for the work and the best service. To relieve the inspectors of a great deal of work outside of the regular inspections of vessels, eight examining boards are to be created for the purpose of examining and licensing officers of the merchant marine and to try cases of misconduct. Under the present system such cases are first investigated and then the trials conducted by the same officials. This recommendation would be good if the number of boards provided were adequate, but it seems very doubtful if eight such boards could accomplish the work.

It is proposed to make more vessels subject to inspection than at present, not only to insure their being properly inspected and equipped, but also that they may have on board regularly licensed officers. All steam vessels and all motor boats carrying passengers for hire are to be subject to inspection. Also all steam and motor vessels of more than 35 feet between perpendiculars. It was considered advisable to make the measurements by length rather than by tonnage, as this is a simpler and just as satisfactory method. Instead of limiting the inspection of sail vessels to 700 gross tons or over, all sail vessels of 300 gross tons or over and all sail vessels of 50 gross tons or over, carrying passengers for hire, are to be included.

Apparently no discrimination is made between an ocean-going steamship and a small motor boat in the provision requiring that all steam and motor vessels carrying passengers for hire and engaged in a service which may at any time take them more than forty miles offshore shall be equipped with an efficient wireless telegraph apparatus, and shall carry a competent operator for the same.

Coming to the personnel on board of vessels, it is difficult to interfere with routine matter on board ship; and, furthermore, the usage in all merchant marines is such that it protects those serving on board from overwork, except in cases of emergency. There are some specific cases where complaints have been laid before the commission, which have received their attention, not only in justice to those whom it affects, but also for the safety of the passengers and the vessels. It is stipulated in the report that it will be unlawful for the master of a seagoing vessel to permit an officer to take charge of the deck watch, immediately after leaving port, who has not had at least four hours off duty before taking such watch.

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Progress of Naval Vessels.

The Bureau of Construction and Repair, Navy Department, reports the following percentages of completion of vessels for the United States navy:

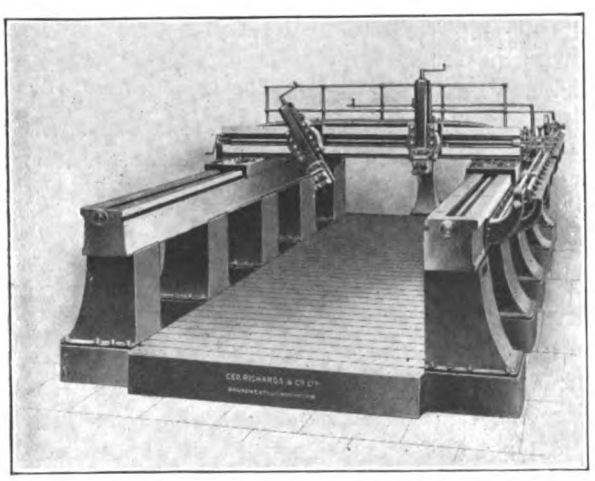
	Tons.	Knots.		Jan. 1.	Feb. 1.
BATTLESHIPS.					
S. Carolina..	16,000	18½	Wm. Cramp & Sons.....	75.1	78.9
Michigan ...	16,000	18½	New York Shipbuilding Co..	85.1	89.7
Delaware ...	20,000	21	Newp't News Shipbuilding Co.	59.0	64.1
North Dakota	20,000	21	Fore River Shipbuilding Co..	67.4	70.6
Florida	20,000	20¾	Navy Yard, New York.....	0.0	3.3
Utah	20,000	20¾	New York Shipbuilding Co..	0.0	3.1
TORPEDO-BOAT DESTROYERS.					
Smith	700	28	Wm. Cramp & Sons.....	62.8	65.2
Lamson	700	28	Wm. Cramp & Sons.....	61.8	63.8
Preston	700	28	New York Shipbuilding Co...	57.9	59.3
Flusser	700	28	Bath Iron Works.....	50.0	55.3
Reid	700	28	Bath Iron Works.....	48.5	54.6
Paulding ...	742	29½	Bath Iron Works.....	3.0	3.7
Drayton	742	29½	Bath Iron Works.....	3.0	3.7
Roe	742	29½	Newp't News Shipbuilding Co.	4.6	10.2
Terry	742	29½	Newp't News Shipbuilding Co.	4.8	9.5
Perkins	742	29½	Fore River Shipbuilding Co..	3.8	6.7
Sterrett	742	29½	Fore River Shipbuilding Co..	3.8	6.7
McCall	742	29½	New York Shipbuilding Co...	3.4	5.8
Burrows	742	29½	New York Shipbuilding Co...	3.3	5.8
Warrington..	742	29½	Wm. Cramp & Sons.....	0.0	6.2
Mayrant	742	29½	Wm. Cramp & Sons.....	0.0	6.5
SUBMARINE TORPEDO BOATS.					
Stingray	...	..	Fore River Shipbuilding Co..	68.0	69.9
Tarpon	...	..	Fore River Shipbuilding Co..	66.9	71.0
Bonita	...	..	Fore River Shipbuilding Co..	63.0	68.4
Snapper	...	..	Fore River Shipbuilding Co..	62.3	65.6
Narwhal ...	...	..	Fore River Shipbuilding Co..	58.7	70.0
Grayling ...	...	..	Fore River Shipbuilding Co..	57.4	64.7
Salmon	...	..	Fore River Shipbuilding Co..	54.9	61.3

ENGINEERING SPECIALTIES.

A Turbine Planing Machine.

The machine consists of two beds, 36 feet 9 inches long, with sliding saddles and cross arm, the beds being supported by legs mounted on a heavy girder baseplate, 20 feet wide, 12 inches deep, and extending the entire length of the machine. The beds are of heavy section and the distance between them is 14 feet 2 inches, enabling the tool to plane across the top of work 14 feet wide and down the sides of work 12 feet wide, and to receive work under the tools 7 feet deep and 30 feet long.

The cross arm is driven backwards and forwards by pulleys through bevel gears, and two steel screws in the beds of 4



inches diameter, giving a cutting stroke of 35 feet per minute in either direction. On the cross arm are mounted two tool slides carrying the tool rams, which can be swivelled to any angle and have a down-feed of 30 inches in all positions. The reversing mechanism to the cross arm is quite independent of the feed arrangement, and the feed is only put on when the feed levers on the saddle come in contact with the stops, enabling the machine to be stopped or started by hand, in either direction, without putting on the feed. This reversing mechanism is operated from a platform placed at the back of the cross arm by a lever having a sector on the lower portion of it, which gears with a pinion on the square reversing shaft. On the end of this square shaft is another pinion, which gears with a sector and lever connected to a plate, which has scroll slots cut in it to receive rollers on the belt forks. There are two belts for driving the machine when on the cutting stroke, and two for the return stroke, to obviate the use of wide belts, which are not easily moved from one pulley to the other. The base plate is built up in sections, tongued and grooved, and securely fastened together by bolts, the top being planed true and having T-slots cut out of the solid. Along the side of the bed is a rail, which carries the feed and reversing stops and sliding bearings for the square feed and reversing shafts. These bearings are pushed along the rail by the saddle, and are so arranged that the shafts are always supported about half-way when the saddles are at the ends of the beds. The feed is operated by stops secured to the rail along the side of the bed, which, coming in contact with the feed levers, bring the clutch on the square shaft into gear, causing the feed disc to revolve, and through the feed levers move the feed pawl either forward or backwards, according to the direction in which the cross arm is traveling. This feed mechanism is so arranged that the feed can either be put on at the cutting end of the stroke or at the return end, or at both ends. The feed is varied by means of a plate at the side of the feed gear and a catch piece fixed to the feed pawl. To obtain the maximum feed, the plate is turned by means of a thumb wheel and pinion to such position that the recessed part of the plate occupies the arc made by the feed pawl, and the catch piece is therefore not affected by the plate, as the pawl is in gear from the commencement of its stroke. To shorten the feed, the plate is placed in such position that the catch piece, which is attached to the feed pawl, rides on the top of the feed plate until it comes opposite the recessed portion, when it allows the pawl to drop into gear and put on the feed. The maximum feed is 1 inch and the minimum 1/24 inch. For broad cutting, which, of course, is done with the machine cutting in one direction only, any feed up to 2 inches can be obtained.

The total weight of the machine is 75 tons, and it is adapted for taking heavy cuts, running at high speeds. Geo. Richards & Company, Ltd., Broadheath, near Manchester, are the manufacturers.

Towing Machines for Dredging Operations.

The use of towing machines of smaller sizes is rapidly growing in favor among dredging companies and contractors. They not only allow towing to continue under weather conditions that would otherwise be impossible, but they also save money in smooth water. The steel hawsers on the towing machines cost less, last longer, and do away with practically all the labor required for handling manila lines. The small machine shown in the illustration is one of several built by the American Ship Windlass Company, of Providence, R. I., for a progressive American dredging company. This machine has cylinders 7 inches by 7 inches, and uses a ⅞-inch diameter steel hawser. This replaces 7-inch to 9-inch manila lines on small tugs. With the automatic winding device shown no after towing bitts are required. The machine is simply bolted in their place, and can be installed over night.

The large machine shown in the illustration is for installation on a large dredge now building in Scotland, designed for work on the Lagos Bar on the east coast of Africa. The dredge has to be equipped with such a device in order to allow for the swells and heavy seas that sometimes break over this bar.

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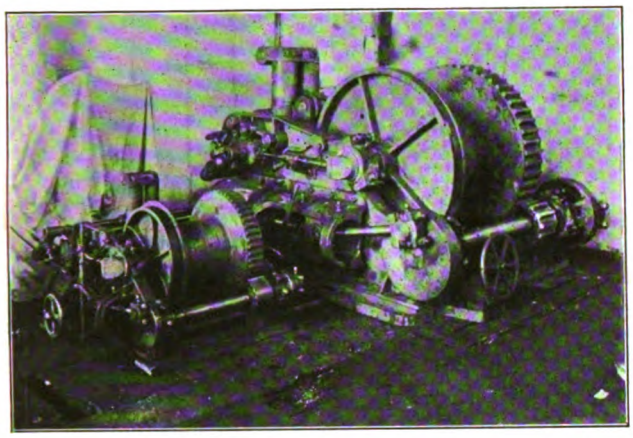
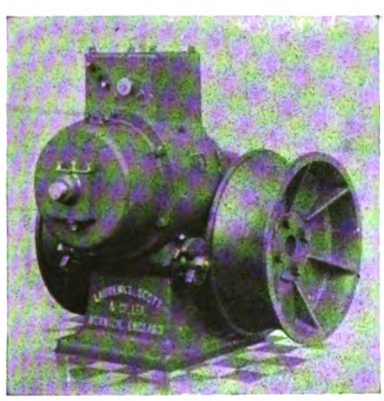
This machine has cylinders 16 inches by 16 inches, and uses a galvanized steel hawser 2 inches in diameter. It is equipped with the American Ship Windlass Company's patent automatic winding device, which consists of a pair of guide rolls, which move back and forth across the drum in such a manner as to lay the line evenly—no matter which direction it leads or how



often it is reversed. With such a device the line can be reeled in or paid out as rapidly as circumstances require, and there is no need for any manual attention. This automatic winding device is a comparatively recent invention, having been in service only two years, but in this time it has proven itself so useful that it is now regarded as an essential part of an up-to-date towing machine.

An Electric Hoist.

Orignally designed for the Admiralty some six years ago, the electrically-driven whipping hoist shown in the illustration has since been manufactured at the Gothic Works of Laurence, Scott & Company, Ltd., Norwich, for the navy and mercantile marine. The motor, as can be seen, is combined with the gear case. As it is compound wound, it only requires a simple



starting switch, which can be placed at a distance from the hoist below decks, where it can be kept dry; or, if this is not practicable, the more expensive deck pattern of starting switch can be used. Simplicity in operation is the chief advantage claimed for this type of hoist. There are no resistances which are liable to burn out. The whole machine is inclosed and watertight, so that it is quite suitable for fixing on deck exposed to the weather. Lubrication is automatic, so that the hoist is always ready for use whenever current is available. These winches are made in two sizes, one designed to lift at Admiralty rating 300 pounds at a speed of 180 feet per minute, and the other, by the same rating, 600 pounds at 180 feet per minute, so they are suitable for handling baggage on passenger ships.

COMMUNICATION.

Government versus Private Work.

Editor, International Marine Engineering:

In view of the editorial published on page 40 of your January issue, relative to government versus private work, the following comparison of the cost of docking, overhauling zincs and sea valves, painting and undocking in the case of a small naval cruiser which was docked at the Mare Island Navy Yard, in July, 1906; again in February, 1907, and which was docked at a commercial drydock in November, 1907, may be of interest:

ITEM.	Labor.	Material.	Total.
July, 1906—N. Y., M. I. Nine Days in Dock.			
Docking	116.68	21.86	138.54
Overhauling zincs and sea valves	76.09	43.84	119.93
Painting	65.80	177.80	243.60**
Grand total	258.57	243.50	502.07
February, 1907—N. Y., M. I. Two Days in Dock.			
Docking	246.50	22.60	269.10
Overhauling zincs and sea valves	19.00	16.70	35.70
Painting	43.10	237.60***	280.70
Grand total	308.60	276.90	585.50
November, 1907—S. F. D. D. Co. One Day in Dock.			
Docking	.....	.....	289.50*
	225. contract † Making Zincs		
Overhauling zincs and sea valves	14.10	67.30	306.40
	Contract		
Painting	120.00	268.30	388.30a
Wharfage	.....	.....	6.10
Use of float	.....	.....	2.00
Grand total	.....	.....	992.30

** One coat of anti-corrosive (392 lbs.) and one coat of anti-fouling (560 lbs.).
*** One coat of anti-fouling (770 lbs.).
a One coat of anti-corrosive (504 lbs., about) and one coat of waterline paint (532 lbs., about).
} Rahtjen's Red Hand Brand.

* Docked at 15 cents per ton displacement.
† The zincs were made at the Navy Yard. The contractor furnished the necessary labor to drill and secure them and replaced all broken screws.

It is often very difficult to get a comparative line on the cost of similar work performed in government yards and in private yards. But this instance seems to afford a fair comparison. Please note the considerable difference between the cost of the work when done in the navy yard and the cost of the same work on a private dock. Particular attention is invited to the job of overhauling zincs and sea valves. At the July docking the vessel was in dock nine days, and the sea valves were ground in. At the February docking the vessel was in dock two days. No valves were ground in, but the zincs on the outside were replaced. At the November docking, where a commercial drydock was used, the work done was practically the same as at the February docking, except that the manufacture of the zincs, costing $81.40, was charged in with the item of replacing them, so that the real comparative figures for this item for these two dockings are $35.70 in the navy yard and $225 in private dock.

It should further be noted that the commercial dock was a floating dock, and it is generally conceded that docking on this type of dock is cheaper than on the graving dock at the Mare Island Navy Yard.

H. S. Wright.

Naval Constructor, U. S. N., U. S. Navy Yard, Mare Island, Cal.

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TECHNICAL PUBLICATIONS.

The Design and Construction of Ships. Vol. I. By Prof. John Harvard Biles. Size, 6 by 9 inches. Pages, 423. Figures, 281. London, 1908: Charles Griffin & Company, Ltd. Philadelphia, 1908: J. B. Lippincott Company. Price, 25s. net.

The author of this book has been lecturing for many years in Glasgow University on the subject of naval architecture, and, while these lectures were never published, notes have been taken from time to time, and these finally collected and elaborated, modified and rewritten, until they have now been incorporated into the valuable volume which has just come from the press. This volume deals only with the calculations and strength of ships. It is divided into three parts, the first dealing with areas, volumes and centers of gravity; the second with ship calculations, and the third, with the strength of ships. Throughout the entire book a complete mathematical demonstration of each subject is given, numerous illustrations being used where their use will in any way aid the student to an understanding of the problem. The book is not entirely a collection of mathematical demonstrations, however, as might be supposed from the subjects considered, but contains a great amount of practical information regarding all types of ships and various details of their construction. While the book does not pretend to lay claim to much originality, yet there is much in the book which, although hitherto published and quite generally known, is the result of investigations and the development of methods by the author himself.

Steam Turbines. By James Ambrose Moyer. Size, 6 by 9 inches. Pages, 370. Figures, 225. New York, 1908: John Wiley & Sons. Price, $4.00.

Written primarily for practical engineers who are designing, operating or manufacturing steam turbines, this book begins with a discussion of the simple problems of turbine design. Much that has not hitherto been readily accessible on the subject of nozzle design is carefully discussed in the opening chapters. After this, steam turbine types and blade design are taken up. Nearly eighty pages are devoted to complete descriptions of various commercial types of turbines now in use. The illustrations in this part of the book show, not only the main features of the turbine, but also a great many of the smaller details which can usually be obtained only by inspection of an actual machine. Turbine governors are described, and a chapter is devoted to low-pressure turbines. The chapter devoted to marine turbines is less than two pages long, and, consequently, simply gives a brief statement of the progress which has been made in the development of marine turbines, pointing out its advantages and disadvantages.

One subject which we have never seen treated so thoroughly before in any book on steam turbines is "Steam Turbine Economics," in which the question of the best conditions of vacuum, superheat and steam pressure are discussed. The data given on power plant economics, giving the cost of installations, will also be found of great value. The final chapter treats briefly of the subject of gas turbines.

Marine Propellers. By S. W. Barnaby. Size, 5½ by 8½ inches. Pages, 185. Figures, 56. Plates, 6. New York, 1908: Spon & Chamberlain. Price, $4.50.

This is the fifth edition of a book which for the past twenty-three years has been widely quoted as an authority on the subject of propeller design. This edition comprises very few changes, as recent experiments have not greatly altered the methods previously used for designing propellers. A note has been inserted giving the latest values obtained by Mr. Froude for the maximum efficiency obtainable at different pitch ratios, and this should be noted when the constants are being selected.

A short chapter has been added, giving some information as to the latest practice in designing propellers for turbine vessels. Another subject which has been added is the influence of depth of water on resistance, since much experimental work on this subject is now available, so that definite information can be given.

The chapters are as follows: First Principles; The Paddle-Wheel; The Screw; Experiments with Models and Their Application to the Determination of the Most Suitable Dimensions; Influence of Depth of Water on Resistance; Cavitation; Geometry of the Screw; The Hydraulic Propeller; The Screw Turbine Propeller.

The Boys' Book of Steamships. By J. R. Howden. Size, 8¼ by 5¾ inches. Grand Richards: London. Price, 6/-; $2.00.

Mr. Howden has followed his former book, *The Boys' Book of Locomotives*, with this present work, in which he deals in an exceedingly interesting and practical way with the steamship. He seems to have gathered his information from all sources, and has written in a very lucid style. The hundred or so illustrations are from excellent photographs, and make the whole volume very attractive. The first chapters deal in a general way with the principles of ship design, the coming of steam and the development of types. We were particularly attracted by the way the author deals with "The Engines" and "Propelling Machinery"; also the chapter, "Down in the Stokehold," is well told. The last section of the book is four chapters on ocean steamships, with special accounts of the chief ocean lines. It will be seen how comprehensive the book is when we state that the author covers the ground from Noah's Ark to the *Mauretania*.

Obituary

The death is announced of Dr. Francis Elgar, chairman of Messrs. Campbell, Laird & Company, and chairman of the Fairfield Shipbuilding & Engineering Company. Dr. Elgar was formerly assistant to the late Sir. E. J. Reed, and following this spent a period of four years at the Admiralty. This appointment he resigned to become adviser upon naval construction to the Japanese government. In 1881 he returned to England, and later became director of His Majesty's Dock Yards at the Admiralty. From 1892 to 1906 Dr. Elgar was director of and naval architect to the Fairfield Shipbuilding & Engineering Company, of which he became chairman in 1907. In the same year he also became chairman of Messrs. Campbell, Laird & Company.

SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

900,680. BOAT. WILLIAM B. MOTHERAL, OF NORTH McGREGOR, IA., ASSIGNOR TO GLIDING BOAT COMPANY OF AMERICA, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

Claim 2.—A boat having a wedge-shaped hull with a bottom curved in cross section, the greatest curvature being near the bow, and the least near the stern. Six claims.

901,157. SHELL OR CASING FOR STANDARD TORPEDOES. CLELAND DAVIS, OF THE UNITED STATES NAVY, ASSIGNOR, BY MESNE ASSIGNMENTS, TO NATIONAL TORPEDO COMPANY, OF NEW YORK, N. Y., A CORPORATION OF MAINE.

Claim 3.—A torpedo shell of standard length provided with a head adapted to slide and to be completely housed therein, and means to force said head outward into its firing position. Ten claims.

905,338. DISCHARGE DOOR OF HOPPER DREDGERS AND BARGES. FRED LOBNITZ, OF RENFREW, SCOTLAND.

Claim 3.—In hopper dredgers and barges having discharge doors, the combination with the doors thereof, of movable bars, means connecting the bars to the doors, a block with a slot therein, means for moving the block, and a wedge which can be driven through the block so as to simultaneously hold all the doors fast. Twelve claims.

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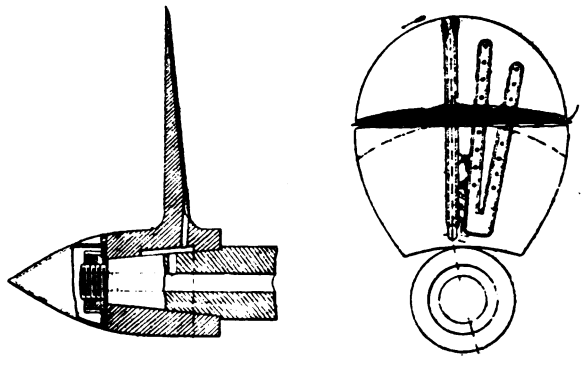
900,797. SCREW PROPELLER. DAVID W. TAYLOR, OF WASHINGTON, D. C.

Claim 6.—The method of preventing cavitation at screw propellers which comprises admitting the air from the cavity formed at the back of the blades into the body of the blades and exhausting it therefrom by an

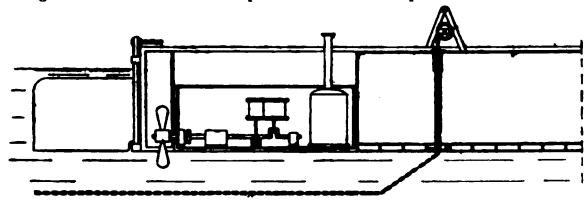


entraining current of water moved by centrifugal force through the blade.

Claim 14.—A propeller blade having a recess formed therein communicating with the cavity formed in the water at the back of the blade and means for automatically exhausting said recess. Fifteen claims.

905,377. RIVER BOAT. PIERRE SIGAUDY, OF LE HAVRE, FRANCE, ASSIGNOR TO STE. DES MESSAGERIES FLUVIALES DE FRANCE AND STE. AME. DES FORGES ET CHANTIERS DE LA MEDITERRANEE, OF PARIS, FRANCE.

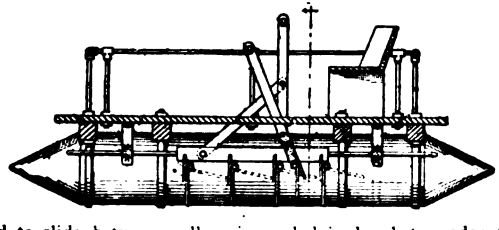
Abstract.—This invention relates to river boats, and comprises a movable platform arranged at the stern of the boat for supporting the whole of the propelling machinery, including the paddle wheels or the screw, according to which of these propellers is employed in addition to the engine or motor and the position of which platform can be altered



according to requirements. When the boat is provided with one or more screw propellers they can be caused to work entirely in the water. Moreover, the boat is provided with a traction chain or rope adapted to drag upon the bottom of the river or canal when required, so as to constitute a brake and enable the boat to resist the drawing action of strong currents. Two claims.

907,303. BOAT. ALEXANDER G. WILKINS, OF LOUISVILLE, KY.

Claim 1.—In a boat of the character described, a series of hinged paddles supported upon a bar, means for stopping said paddles in a vertical position, rods connected to said supporting bar, said rods being



mounted to slide between rollers journaled in brackets under the deck of the boat, and manually-operated means for reciprocating the supporting bars and paddles. Three claims.

907,629. PORTABLE FOLDING BOAT. PAUL J. MURPHY, OF MINNEAPOLIS, MINN.

Claim 2.—In a portable folding boat, the combination with a folding box-like frame adapted to house the hulls and the working parts when detached and placed therein, of a pair of hulls, each composed of a hollow cylinder having detachable and reversible cone-shaped end sections adapted to telescope therein, when reversed, to reduce the housing length of the hulls, the bodies of which are of less length than said box-like frame. Four claims.

908,016. METHOD OF RAISING SUNKEN VESSELS. SIMON LAKE, OF BRIDGEPORT, CONN.

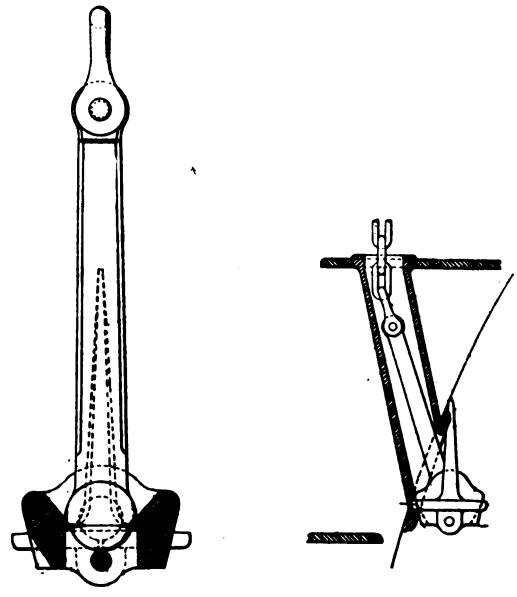
Claim 6.—The method of raising sunken vessels, which consists in closing the upper openings in the vessel and then forcing into the interior a fluent buoyant material capable of solidifying in water and containing paraffin and cork, said material being admitted in quantities sufficient to displace enough water to permit the vessel to be floated. Seven claims.

908,270. TORPEDO-LAUNCHING TUBE. ALBERT EDWARD JONES, OF FIUME, AUSTRIA-HUNGARY, ASSIGNOR TO WHITEHEAD & CO., OF FIUME.

Claim 1.—In combination with a torpedo launching tube, a rod arranged outside of the tube and displaceable lengthwise, said rod being connected with the firing mechanism, enlarged members formed on the rod passing through supporting boxes on the launching tube, said members being provided with grooves curved in opposite directions for engaging the torpedo stop and starting bolts. Six claims.

907,957. SNUGLY-STOWING STOCKLESS ANCHOR. WALTER S. BICKLEY, OF CHESTER, PA., ASSIGNOR TO BALDT ANCHOR COMPANY, A CORPORATION OF NEW JERSEY.

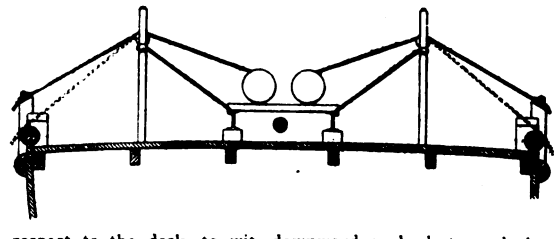
Claim 1.—In a stockless anchor, a crown member having flukes, a shank, a central opening in one side of said crown member to receive said shank, a substantially spherically shaped socket in said crown piece, a ball member integral with said shank and bearing in said



socket in said crown piece, the rear surface of said ball member being of continuous substantially spherical shape of less diameter, and a pin extending through said crown piece and in proximity to the continuous substantially spherical end of said shank. Twelve claims.

908,168. OYSTER-DREDGING CHOCK. WILLIAM C. TODD, OF CHANCE, MD.

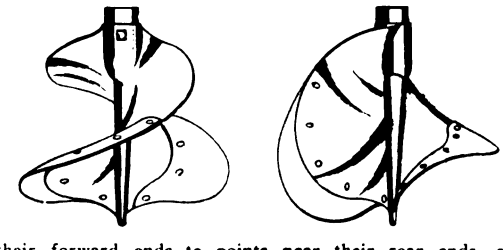
Claim.—A roller-chock for oyster-dredging vessels, comprising a block secured to the side of the vessel and at an elevation above the deck, and a grooved roller mounted on said block and inclined in two directions



with respect to the deck, to wit, downward or back toward the stern of the vessel, and also downward or sidewise from the deck toward the water. One claim.

908,226. SCREW PROPELLER. OLE P. EGGAN, OF SEATTLE, WASH.

Claim.—A screw propeller comprising a forward socket equipped with means for fixing it on a propeller shaft, a longitudinal central body portion formed integral with and extending rearwardly from said socket and having a rear, tapered end, and spiral blades extending in the direction of the length of the body portion and increased in width



from their forward ends to points near their rear ends, and each having an inner portion integral with the body portion and an outer portion attached to the inner portion and adapted to be removed and replaced with a new outer portion when necessity demands; the said tapered rear end of the body portion extending in rear of the rear ends of the blades, and the said blades being relatively arranged to form spiral channels between them. One claim.

909,321. TORPEDO. EDWARD O'TOOLE, OF LONDON, ENG.

Claim.—A self-destructible torpedo comprising a submerged body, a propeller therefor, an engine arranged within the body and operatively connected with the propeller, an air pipe communicating with said engine and projecting continually beyond the water level with its upper end extending toward the rear of the body to prevent water from entering therethrough during the passage of the torpedo through the water, a fan driven by said engine to suck air into the body for said engine, an exhaust pipe leading from said engine, a brace arranged between the exhaust and air pipes and a stationary guiding vane connected to the body. One claim.

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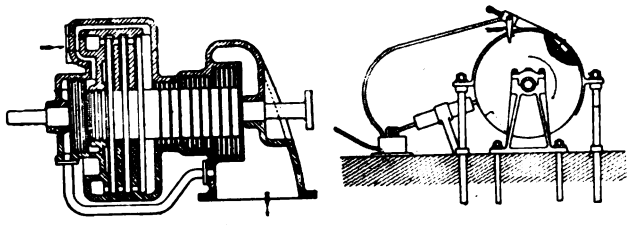
British patents compiled by Edwards & Co., chartered patent agents and engineers, Chancery Lane Station Chambers, London, W. C.

15,361. TURBINES. J. KARRER, ZURICH, SWITZERLAND.
The annular steam jet from the last row of blades of a turbine is arranged to discharge into an adjacent chamber into which it draws water for its own condensations. The steam jet from the last rotor passes through fixed passages into the chamber, water being drawn in from another chamber. The mixture passes through a constriction to the discharge. The condensing water may be supplied under pressure, and the annular chamber may be placed internally. The arrangement is applicable to any turbine using condensible motive fluid.

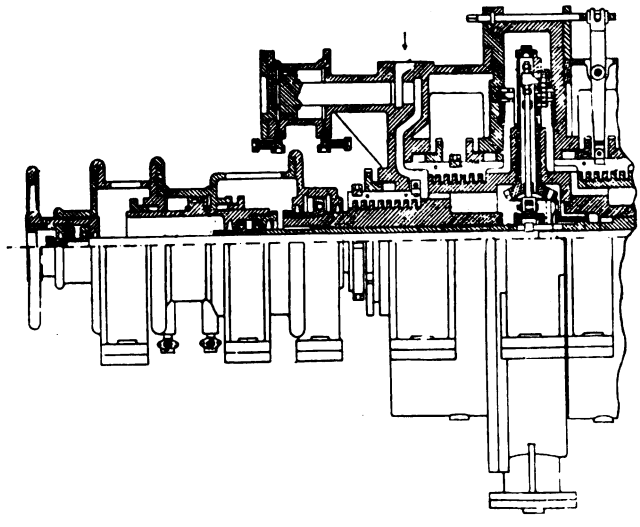
16,186. RAISING SUNKEN SHIPS. J. HAIGH AND J. GOLDSWORTHY, WALLASEL, CHESHIRE.
Submerged or partly submerged ships are raised by means of tanks which are filled with water and attached to the hull, the water then being ejected by means of compressed air. The tanks are provided with tubes for the passage of the chain, and, after lowering, the free ends of the chain are connected by a shackle. The compressed air is admitted through flexible tubes and the water is forced out through valves. Other means may be employed for attaching the tanks to the object to be raised, and collision mats may be placed between the tanks and the hull.

16,523. TURBINES. BROWN, BOVERI, ET CIE., AKT.-GES., KAFERTHAT, GERMANY.
In elastic-fluid turbines of the combined impulse and reaction type, the balancing piston is arranged at the high-pressure end of the turbine, so that its labyrinth packings are subjected to steam which has



passed through the expansion nozzles of the impulse part. A duct leads steam from a region between the impulse section and the reaction section to one side of the balancing piston. When the impulse section is of the Curtis type the wheel may be perforated and the connecting duct dispensed with.

16,996. TURBINES. J. PROCNER, PABLANICE, POLAND.
In a reversing turbine the nozzles and the corresponding bladings rotate and the intermediate bladings are fixed to the casing. In each stage two sets of intermediate bladings are provided, and to reverse the direction of running the nozzles and bladings are rotated to remove them from interaction with one set of fixed bladings to interaction with the other set. For this purpose the nozzles, etc., are attached to arms which are mounted to rotate upon their own axes within the arms integral

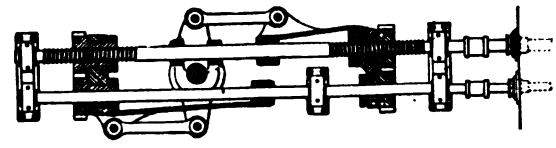


with the four-part shaft. Steam is controlled by a steam-operated piston valve and passes through the channel in the shaft to the center of the hollow arm and thence through the nozzles into the outer chamber. A channel connects this chamber to the center of the hollow arm of the next stage, and so on. The stages are separated by labyrinth packing between the shaft and the casing. The inner ends of the nozzle arms are provided with bevel wheels which engage with wheels on sleeves which are threaded internally with screw threads of very long pitch and engage with correspondingly cut surfaces on a tubular shaft mounted inside the main shaft. This shaft is splined to the main shaft. It is given an axial movement to rotate the sleeves, and thereby the nozzle-carrying arms, by a steam piston.

17,226. TURBINES. WARWICK MACHINERY COMPANY, LONDON.
In a multi-stage turbine in which the stages are separated by diaphragms, the steam from the last buckets of one stage is guided to the nozzles of the next by a passage formed in a block. The forward end of the passage is curved, and a valve is used to regulate the length of the passage. To compensate for the increased width of the passage the depth is reduced in the direction of the flow. Any escape of steam from the wheel chamber outwards is prevented by cylindrical walls.

18,046. TORPEDO TUBES. SIR W. G. ARMSTRONG, WHITWORTH & CO., AND E. W. LLOYD, NEWCASTLE-UPON-TYNE.
An above-water torpedo tube has a permanently closed rear end and a perfectly cylindrical chamber extending from the rear for a distance equal to the distance between the tail and the suspension tee-piece of the torpedo. It is loaded from the muzzle, the tail of the torpedo being passed sideways under the snout. A hole is provided to accommodate the charging-nozzle for the compressed air.

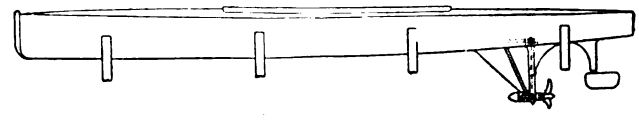
19,373. STEERING GEAR. T. L. LIVINGSTON, JARROW.
In a steering gear, a rudder-head which extends between the screw shaft and the guide shaft is provided with cross-beams, one above and one below the shafts. Levers connect the nuts to opposite ends of the cross-beams, and are so arranged that one is on the aft side of the rud-



der and the other is on the forward side, both being either in compression or tension. A bearing may be fitted on the rudder head to support one or both shafts, and the upper cross-beam may be dispensed with, the bearing being secured to the cross-beam by a circular standard, which is recessed into the upper surface of the cross-beam.

19,424. SHIPS. H. A. MAVOR, GLASGOW, AND J. H. BILES, WESTMINSTER.
A turbo-generator plant is employed for supplying the power to several motors driving the screw propeller shafts of cargo vessels. The generator plant is subdivided in separate units adapted to supply the current to the operating motors of the propeller shafts or the auxiliaries, the units into which the generating plant is divided being proportioned in accordance with the requirements of the different operating motors. One of the units smaller than the others may be used in the event of the failure of a larger unit, to propel the vessel at a reduced speed, or to operate the auxiliaries, the normal periodicity of this unit being half that of the larger unit. The main units of the generating plant may consist of turbo-alternators, while the smaller unit consists of a generator driven by a reciprocating engine, and capable of supplying either direct and alternating current or direct or alternating current, so that the auxiliaries may be driven by direct current.

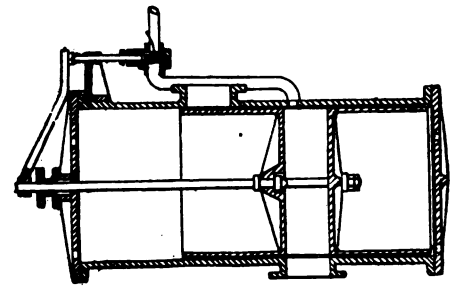
19,496. SHIPS' HULLS. W. P. THOMPSON, LIVERPOOL.
Curved aquaplanes of approximately catenary shape in a transverse direction are attached directly to the sides of the vessel, and, in addition, angular or curved fins are attached to the side of the vessel, but extending outwards. The screw propeller is mounted in a hollow column near the stern, and is driven by bevel wheel or sprocket-chain gearing



from within the vessel, or the propeller shaft may carry the armature of an electric motor completely enclosed in the column. The full catenary aquaplanes are placed in the center and forward parts of the vessel and also abaft the propeller near the stern, the partial aquaplanes being placed towards the stern. A partly floating paddle wheel may be fitted at the stern.

19,509. LIFE-BOATS; RAFTS. C. J. F. VOS, ROTTERDAM, HOLLAND.
Life-boats or rafts are constructed with inner and outer skins of plaited cane, wickerwork, etc., without any rigid framework. Between the skins is interposed a filling of yielding material, such as flock, cork, etc., preferably in three layers, the layers being separated by waterproof canvas layers.

20,107. APPARATUS FOR DISCHARGING ASHES FROM SHIPS BELOW THE SURFACE OF THE WATER. W. R. PRESTON, LONDON, AND G. C. RALSTON, TWICKENHAM.
A double piston with a space between its parts is adapted to reciprocate in a cylinder provided with inlet and outlet openings, respectively. The ashes are expelled through the outlet opening by means of compressed air, etc., the supply of which is governed by a slide valve operated by a tappet rod from the piston rod. As the piston moves



backwards towards the opening for a fresh supply of ash it uncovers a port, by means of which the excess of fluid pressure in the space is relieved. The cylinder ends may have suitably-controlled openings for the admission and discharge of sea water to remove grit in the cylinder.

20,241. VALVES. P. FERGUSON, J. B. PROVAN AND J. ROBERTSON, DUMBARTON.
A check valve for use in discharge pipes on board ship comprises two flaps of semi-conoidal form seating on one another and supported by means of eyes on pins. The pins are carried by lugs on a piece provided with projecting lugs to fit into recesses in the casing, and also with india rubber buffers. The valve casing is formed in the shape of a pipe bend and is closed by means of a cover.

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